MAY 19 1958

CONSTRUCTION • OPERATIONS • MAINTENANCE

B 711713

PIPE LINE INDUSTRY

Gulf Publishing Company

MAY
1958

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For a "Quick Look" at this issue, turn the page . . .

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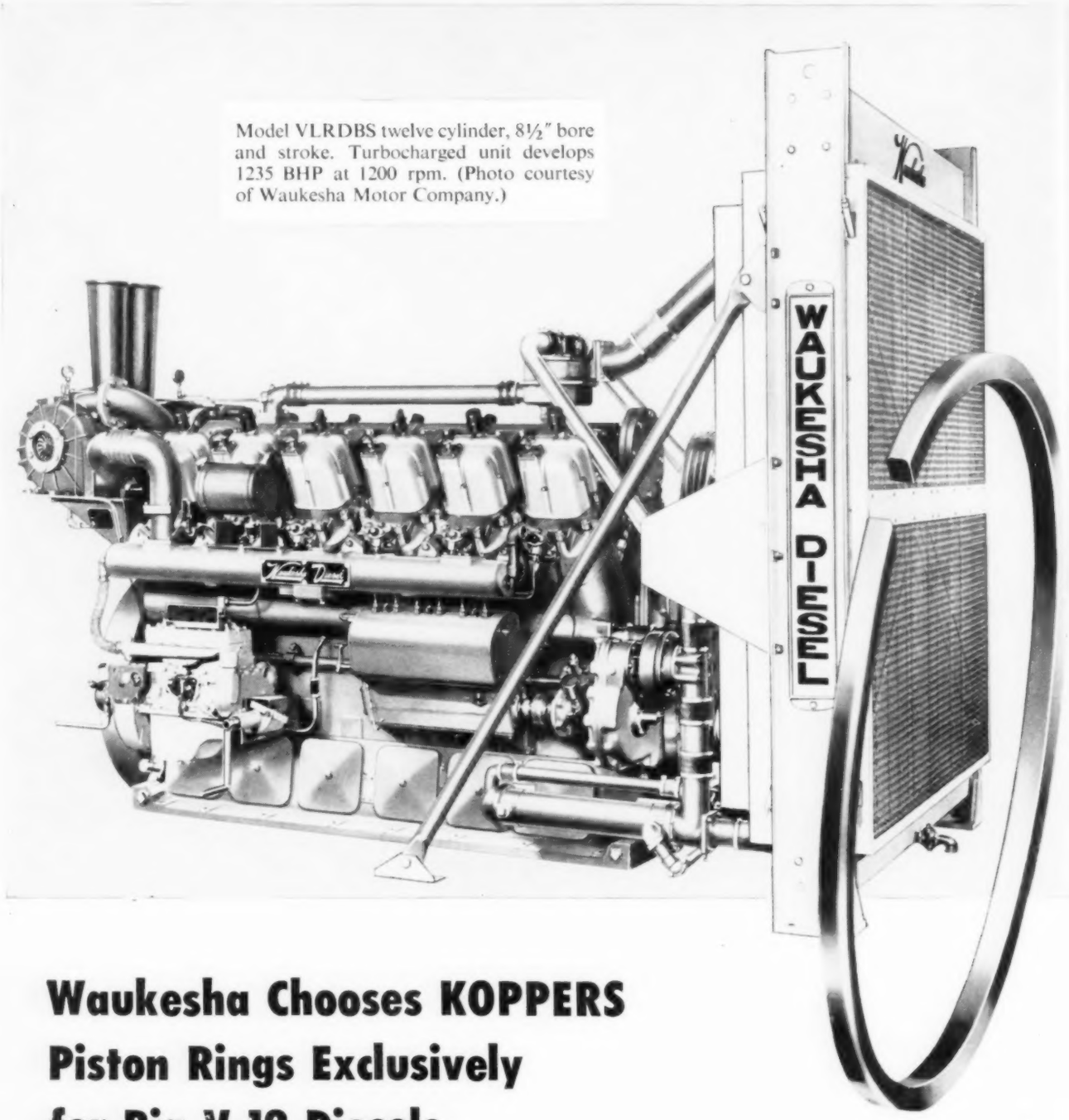

Model VLRDBS twelve cylinder, 8½" bore and stroke. Turbocharged unit develops 1235 BHP at 1200 rpm. (Photo courtesy of Waukesha Motor Company.)

Waukesha Chooses KOPPERS Piston Rings Exclusively for Big V-12 Diesels

Waukesha's VLRDBS supercharged diesels are perfectly suited for applications such as oil rigs, excavators and tugboats where a surge of reserve power is essential for emergency and overload demands.

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Industrial Piston Rings
Engineered Products Sold with ***Service***

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PIPE LINE INDUSTRY

CONTENTS and Quick Look

SERIAL RECORD]
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May, 1958 Vol. 8, No. 5

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Graphs Solve NGL-Crude Blending Problems

☐ When natural gas liquids are blended into a crude pipe line for transportation to the refinery, it is necessary to know the resultant vapor pressure of the mixture. Use of graphs for two and three component mixtures will reduce the time required for calculating the vapor pressure of the blend.

By R. J. Evans . . . . . Page 36

Where Do We Stand in Automatic Control?

☐ Here is a design engineer's progress report on the status of automatic station control today. Some systems are about half-way along the road from manual to completely automatic operation. Equipment is now available or under development that can enable pipe line engineers to go all the way to fully automatic control.

By Newton E. Armstrong . . . . . Page 41

Tester Can Cut Microwave Tube Costs

☐ A portable test set capable of use by field service men has been developed to allow use of the current division method in checking the 2C39 tube and similar high wattage tubes. Use of this instrument will save time in trouble-shooting microwave equipment. Instead of changing out all tubes so the system can be returned to operation in a hurry, the bad tube can be isolated and replaced.

By T. H. Briggs and M. O. Sharpe . . . . . Page 44

Single Line Substitutes for Co-Ax on Microwave Towers

☐ Several gas transmission companies have been testing out these unique low cost antenna lines for over two years. Icing problems did not prove to be serious; communications engineers report that they will be especially suitable for emergency replacements for damaged coaxial cable . . . . . Page 48

How Much Mixing Occurs Between Batches?

☐ Here is a set of graphs developed from theoretical flow principles and field test data that will help you to handle pipe line contamination calculations. This correlation of the variables that affect pipe line mixing will save time when finding percentage contamination and contaminated fraction width for stations downstream.

By Octave Levenspiel . . . . . Page 51

Bolted Access Doors Simplify Tank Cleaning

☐ A new look in clean-out doors has been developed with a bolted door that will not leak and is safe from stress. In the past, access openings on large tanks have been riveted door plates or manway-type openings with bolted covers. The new door is easily installed or removed with regular maintenance crews.

By R. W. Bodley and R. C. Ulm . . . . . Page 55

Mining Methods Used on Giant Gas Line Road Crossings

☐ Today's active roadbuilding programs and larger diameter lines have called for new ideas in installation of road crossings. Contractors laying Carnegie Natural Gas Company's new 43 and 55-inch line used mining methods to jack casings into place under roadbeds. Welders and excavation crews alternated between the two parallel casings to speed up the job . . . . . Page 61

Thin Film Coatings—What They Are

☐ How close do the coal tar-epoxies come to meeting the requirements of the ideal coating for underground protection of pipe lines? A comparison is given along with some of the chemistry behind the development of the epoxy resins. Introduction of the coal tar-epoxies is the result of intensified research due to the rapid development of the new synthetic resins.

By N. T. Shideler and F. C. Whittier . . . . . Page 62

What It Takes to Be a Leader

☐ Pipe line companies need qualified engineers on their management teams. For a detailed description of what you need to do to prepare for management, undesirable traits to be discarded, plus an eight-question management ability test, read this article.

By Major B. Foster . . . . . Page 66

REGULAR MONTHLY DEPARTMENTS

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EDITORIAL PAGE

Improved Outlook for U. S. oil

The worst of U. S. oil's slump likely will terminate by mid-year. There are growing indications to this effect. The outlook does not call for any sharp upturn or boom conditions, but for gradual gains. While it may be sometime before the industry recovers all the ground it has lost, any measurable relief from present low producing levels, pipe line movement and refining activity would be most welcome.

It now seems probable that U. S. oil producing rates may be considerably higher during the last half of 1958 than current low volumes. Certainly, it appears that May will see the lowest point in production. This would be welcome news to U. S. crude oil pipe line companies, who have been feeling the impact of drastic production cuts. The operation of pipe lines at only partial capacity does not make for profitable operations.

Oil's brighter prospects are based on improving conditions within the industry. Should general business activity also recover some of its lost ground, oil's outlook will record very marked improvement.

Chief reasons for anticipating better conditions for U. S. oil are improvements in stocks and the expectation that demand will be larger than current low spring volumes.

Low producing and refining rates during recent months have materially alleviated excessive stocks. Additional stock improvement is promised by establishment of low May production schedules in several leading states. Inventories should be in good shape within another 30 to 60 days.

Therefore, some relief from current low producing rate seems probable. It no longer would be necessary to curtail production below current needs in order to cure excessive stocks. This, in itself, promises that pipe lines can look forward to moving larger quantities of crude production during the last half of 1958.

The usual seasonal upturn in demand also is to be anticipated. Unless there is an unexpected marked worsening of general business activity, U. S. oil demand will start increasing by July and August. Spring months invariably are the lowest oil consuming season of the year, because the industry is between the oil heating season and the motoring season.

The extent of the increase in oil demand will depend on general business activity. Any substantial recovery in general business activity would result in a sizable increase in oil demand rates, which would make necessary a substantial boost in crude oil pipe line movements.

Any size relief from recent low operations will be great news for all branches of the industry.

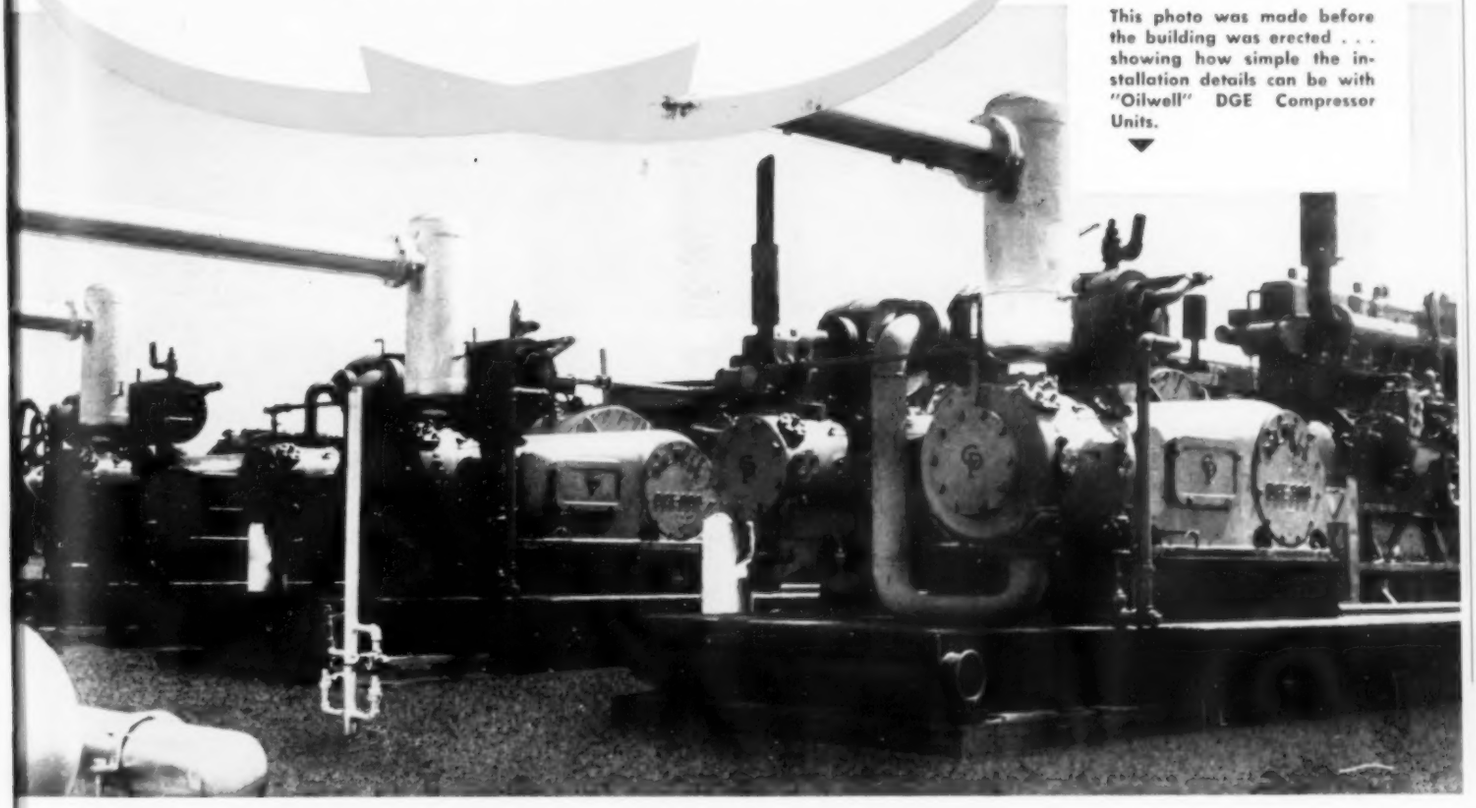
Warren L. Baker

Another Gas-Gathering System relies upon

"Oilwell" Direct-Connected Compressor Units

In this application, cooling fans are positioned outside the building. Updraft action eliminated consideration of prevailing wind problems.

This photo was made before the building was erected . . . showing how simple the installation details can be with "Oilwell" DGE Compressor Units.



Near Graham, Texas, Universoil, Inc. is gathering gas at field pressures of approximately 20 psi and discharging it into transmission lines at 800 psi with "Oilwell" DGE-300 two-stage compressor units. In this installation, each of the three units has a capacity of approximately 1,275,000 cu. ft. per day at compressor speeds of 300 rpm.

These duplex units consist of two slow-speed, horizontal-type compressors with top suction and bottom discharge connections. They are mounted side by side and are driven through right-angle, spiral-bevel gears by a single prime mover—all on a common skid base.

Each unit has its own heavy-duty, horizontal, updraft radiator with divided core for separately cooling the engine and compressor. For 250 and 300 hp sizes, the radiator and fan assembly is mounted adjacent to the engine and driven from the crankshaft by means of a torque tube and fluid coupling.

An "Oilwell" Engineer will be glad to help you select the compressor that is best suited for your next application. Our various units, ranging in size from 20 up to 300 hp, provide a wide choice.

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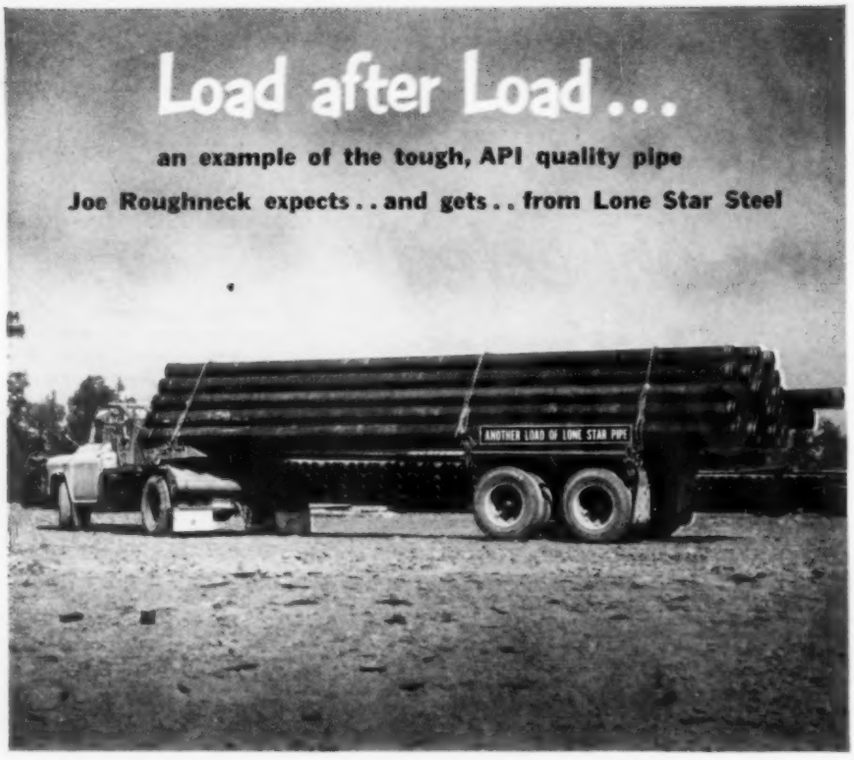
Load after Load...
an example of the tough, API quality pipe
Joe Roughneck expects..and gets..from Lone Star Steel
ANOTHER LOAD OF LONE STAR PIPE

In the heart of the oil country, Lone Star Steel's huge plant is Joe Roughneck's solid source of supply for API casing, tubing and line pipe. Quality-controlled from mining of ore to finished pipe.. Lone Star electric weld pipe meets strict API specifications. Fully normalized, of course.

Crossing rivers, bending over hills and rugged terrain is routine for Lone Star line pipe.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.

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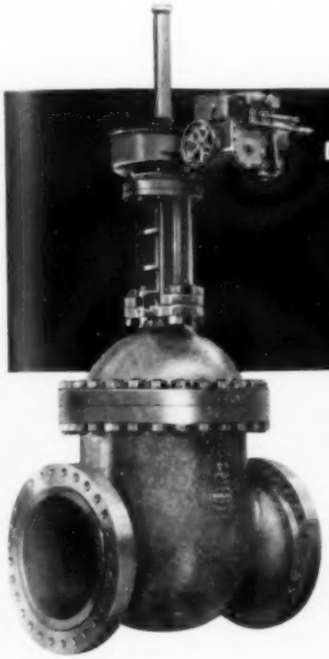
UNMATCHED ADVANTAGES

in every oil, gas and petrochemical service



DARLING FULLY REVOLVING DOUBLE DISC GATE VALVES

—famous for *consistently* trouble-free operation in all kinds of service. Revolving disc principle assures easy operation, surer closure, minimum friction, automatic seating compensation, extreme life with minimum maintenance. Ask for Catalog 57.

DARLING ALUMINUM ALLOY GATE VALVES

—featuring all the advantages of the above revolving disc principle, *plus* new economies in the handling of "problem" fluids and gases or wherever aluminum piping is used. Ask for Bulletin SLS 5801.

DARLING-McEVOY SELF-SEALING CONDUIT VALVES

—the *only* conduit gate valve with *sealant gasketing* between gates and seats. Every closure leak-proof! This and other advantages proved by outstanding performance on major lines. Get *all* the facts. Ask for Catalog 57.

Whatever the service, in any phase of pipelining, gathering or processing, these Darling gate valves offer worthwhile features and advantages unobtainable in other valves. The catalogs referred to above are available to give you the pertinent facts.

DARLING VALVE & MANUFACTURING CO.

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For more data on advertised products, use Readers' Service Cards, last page.

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This Company is ideally situated on the Mississippi-Ohio River system and the great Cincinnati rail-truck hub. New barge facilities, 7 major railroads and 143 motor carriers enable Acme-Newport to give economical, dependable delivery to the entire area of the Middle West and South.

Here is close control in every process, from steel melting, rolling and conditioning to actual pipe forming, straightening, sizing and beveling. Each length is hydrostatically tested to API and ASTM specifications to ensure uninterrupted service. All the qualities you demand for economical line pipe installation are available from Acme-Newport, where modern facilities and well-trained personnel blend with 73 years' steelmaking experience.

Let our pipe specialists tell you more about Acme-Newport's ability to meet your own requirements.

Acme-Newport Steel COMPANY

NEWPORT, KENTUCKY

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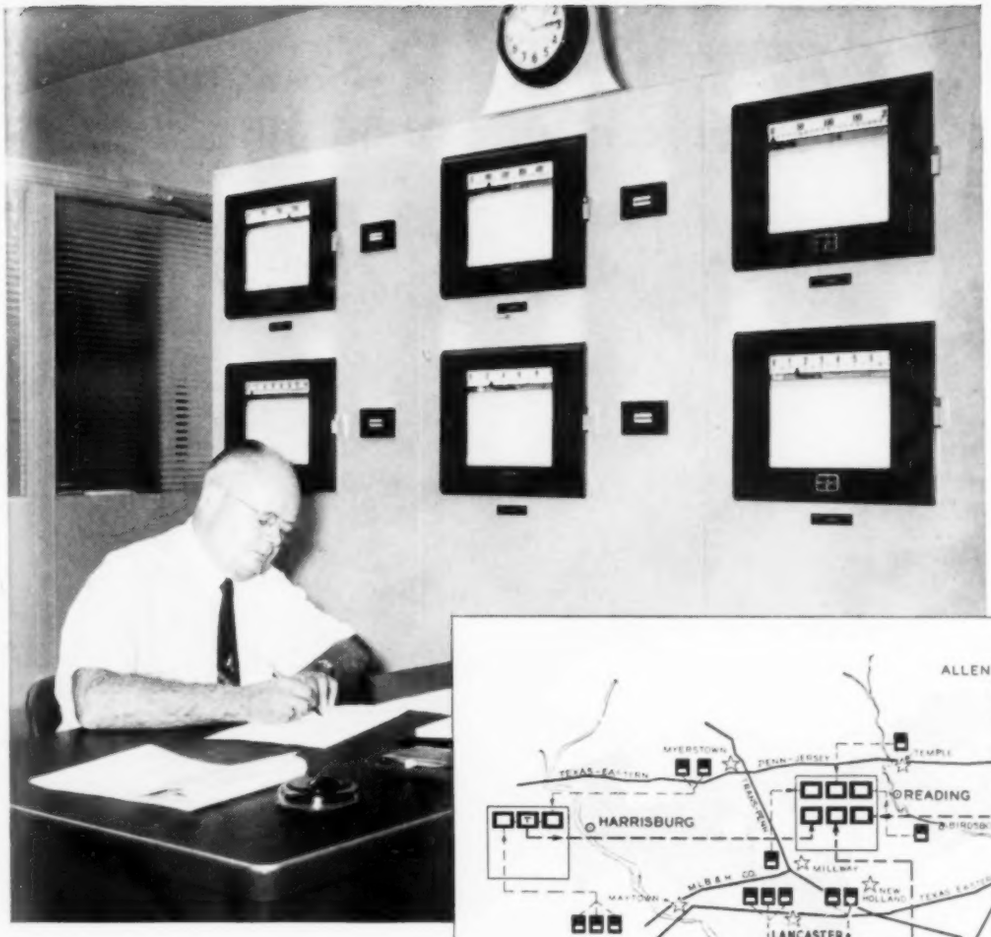
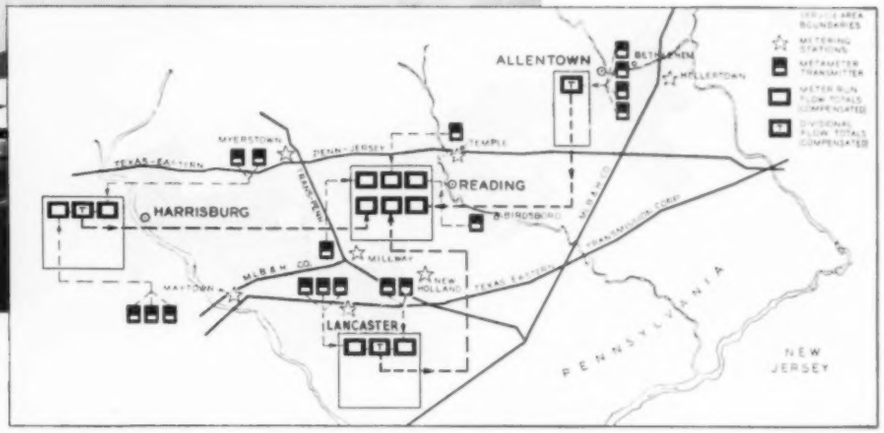
	.142"	6.61
	.156"	7.25
	.188"	8.64
	.219"	10.00
	.237"	10.79
6⅝	.156"	10.78
	.188"	12.89
	.219"	14.97
	.250"	17.02
	.280"	18.97



THE BRISTOL METAMETER* computer at United Gas Improvement Company continuously monitors this gas distribution network, automatically totalizes and corrects flow, and transmits results to central dispatching office at Reading, Pa.
T. M. Reg. U. S. Pat. Off.



BRAIN 60 MILES LONG

computes for this dispatcher

Bristol computing telemeters give gas dispatcher instant, continuous, fully-corrected gas flow values

The instruments you see above are the readout end of a new Bristol computing telemeter system. They're installed at the Reading, Pa., headquarters of United Gas Improvement Company, whose natural gas distribution network serves the areas around Reading, Harrisburg, Lancaster, and Allentown, Pa. (See map.)

In seconds, the Bristol computing telemeters provide the gas dispatcher with integrated total flow values it used to take him hours to get—if at all. And the readings are fully and automatically corrected for factors like pressure, temperature, supercompressability and specific gravity. In fact, the continuously computed readings have generally agreed with the gas vendor's billing meter totals far more closely than the specified 1.5% accuracy.

Find out how a Bristol computing telemetering system can eliminate slide-rule work, information delays and uncertainties from your distribution system for natural gas or any other fluid, whether it covers miles or only a few hundred yards. Write: The Bristol Company, 114 Bristol Road, Waterbury 20, Conn.

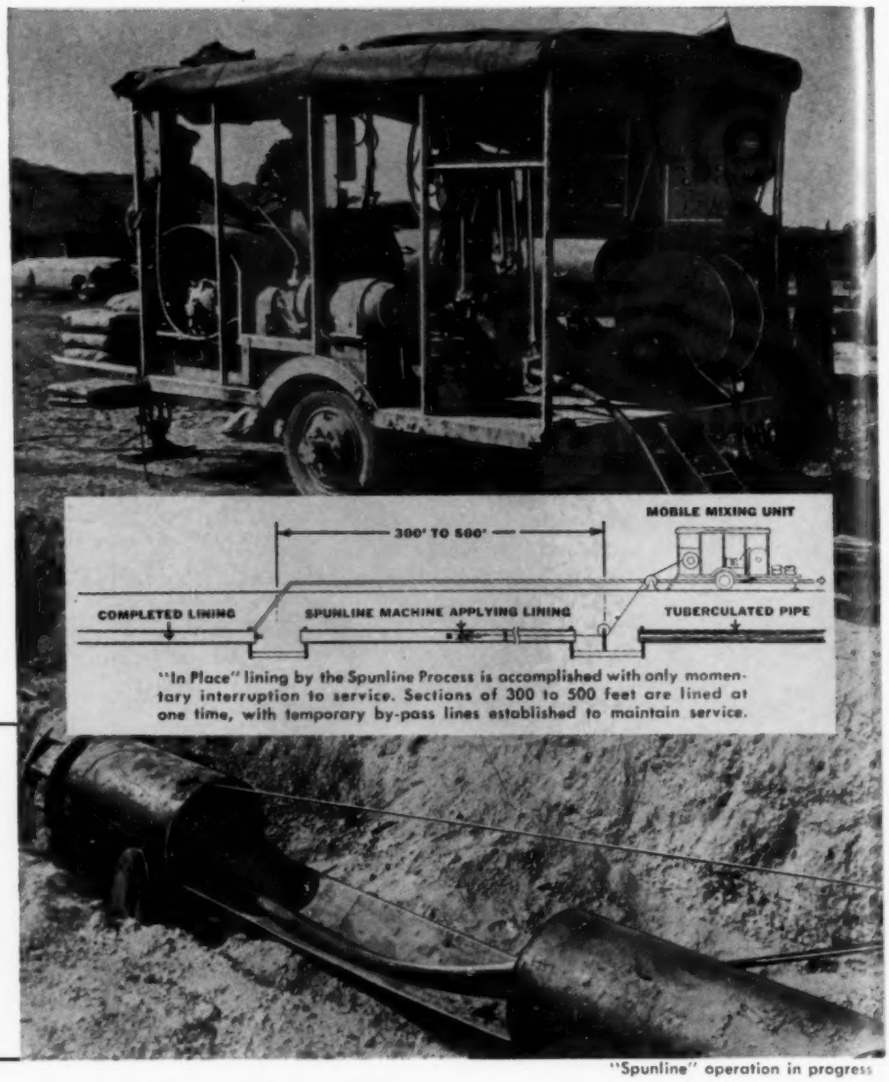
B-9

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more data on advertised products, use Readers' Service Cards, last page.

NEW! "Spunline" Process for cement mortar lining of pipe interiors "in place"

- for pipes 6" to 16" in diameter *(particularly cast iron)*
- Combines best features of world-famous Tate and centrifugal lining processes



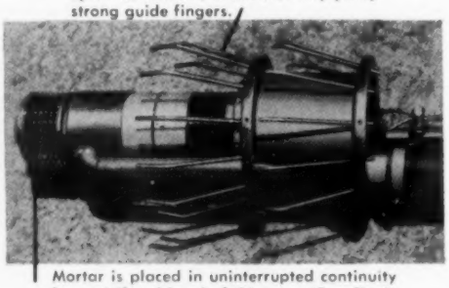
"In Place" lining by the Spunline Process is accomplished with only momentary interruption to service. Sections of 300 to 500 feet are lined at one time, with temporary by-pass lines established to maintain service.

ONLY MOMENTARY INTERRUPTION TO SERVICE!

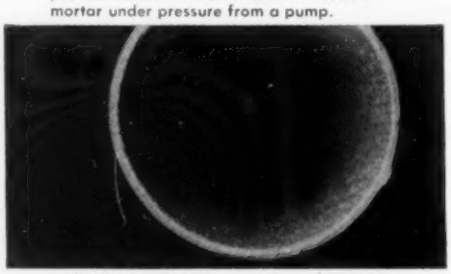
Gives new pipe performance
Restores flow coefficients
Reduces leakage
Reduces pumping and maintenance costs
Protects against corrosion, contamination, and water discoloration at much less than the cost of installing a new line

"Spunline" operation in progress

Spunline machine is centered in pipe by strong guide fingers.



Mortar is placed in uninterrupted continuity by centrifugal head of this new "Spunline" process machine which is fed with cement mortar under pressure from a pump.



Finished surface has orange peel texture.

HOW IT'S DONE

The "Spunline" process might be called a "marriage" of the conventional "in place" Tate and centrifugal processes.

It is a process of applying a cement mortar lining "in place" to small diameter pipe, developed to provide a thin lining for prevention of further interior corrosion and to restore hydraulic flow, particularly in cast iron pipe. The mortar is placed in uninterrupted continuity by a centrifugal machine (a centrifugally rotating head) projecting the mortar against the wall of the pipe (pulled through, as in the Tate process) with minimum rebound and with sufficient velocity to cause the mortar to be densely packed and adhere in place. The finished thickness of the mortar lining may be $\frac{1}{8}$" or more, with a plus or minus variation of $\frac{1}{16}$". The finished surface is not troweled and has an orange peel texture.

Why you'll like the "Spunline" Process

1. Lining can be carried through many bends and certain fittings.
2. Lining can go right past smaller openings or corporation stops . . . no need for plugging such openings.
3. Lining can be thinner than usually applied by other processes, with closer tolerances.
4. Compares favorably in cost with other methods.

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Sometimes it is necessary to recalibrate thermometers in industrial installations due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

To recalibrate the ordinary bimetal thermometer, you must remove the dial glass and move the pointer by hand. You will achieve the desired recalibration of course, but a number of undesirable things may also result. First of all, the instrument's air-tight seal is automatically destroyed in the removal of the dial glass. Secondly, in forcing the pointer, the pointer shaft may become bent or twisted.

Should the pointer shaft become bent even slightly, it can cause the pointer to stick due to improper alignment of the bimetallic shaft on its bearing surfaces. The obvious result, of course, will be inaccurate readings and necessary repair or replacement of the instrument. *None* of these things can happen with the RMC external recalibration device.

A simple dial-reset screw, located on the back side of RMC industrial thermometers, permits recalibration without opening the instrument in any way. This external recalibration feature is *exclusive* with RMC, along with true dry-air hermetic sealing.

SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

RMC high pressure gauge, developed for missiles, now available to industry

RMC-LINDSAY PRESSUREGAUGES indicate pressures in ranges 0 to 1,000 psi., up to 0 to 15,000 psi., with retard scales available. Multiple coil, helical Bourdon tube type, with pointer attached direct—no linkages or pivots. Can withstand extreme shock, vibration, temperature, or overpressure and maintain consistent accuracy.

Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 207 Rockwood St., Rochester 10, N. Y.

This maintenance engineer is recalibrating an RMC bimetal dial thermometer by means of the exclusive RMC *external* dial reset screw—a simple on-the-job operation with RMC thermometers.

RMC external recalibration device saves thermometer's hermetic seal

With this *external* dial reset screw you can recalibrate your RMC thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed and there is no chance for damage to the critical pointer shaft. You get the *only* bimetal industrial thermometer that provides for *external* recalibration when you specify RMC.

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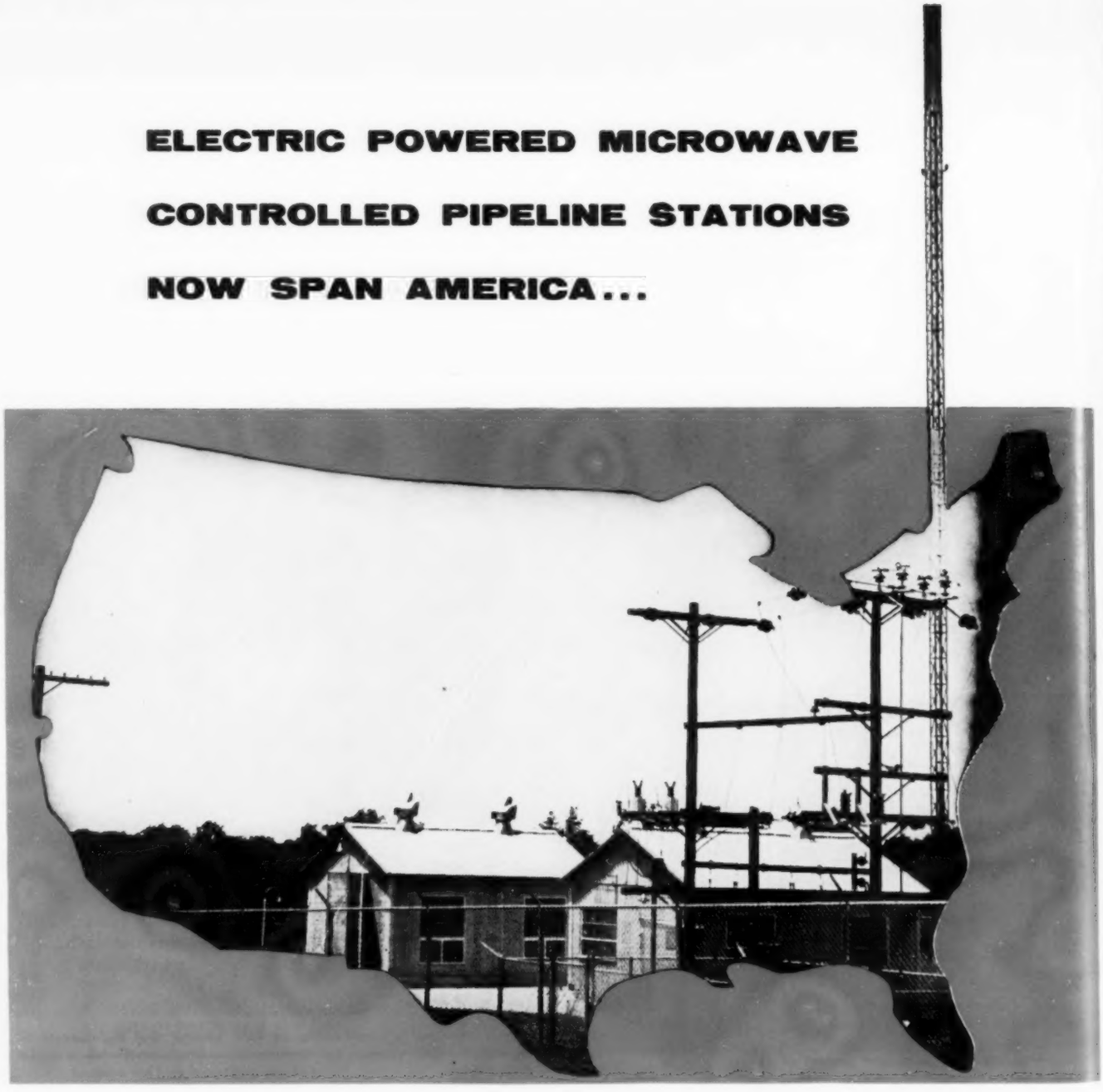
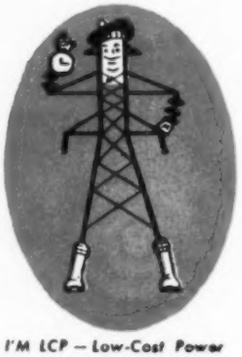


One of many ways progressive management puts UTILITY ELECTRIC POWER to work

If you are in the pipe line transmission business . . . or if you contemplate having anything to do with pipe line transmission operations, don't sign any contract for power until you have carefully investigated the advantages of UTILITY ELECTRIC POWER. Of the 686,000 miles of pipe line systems in America, a big percentage of these is operated by Electric Power. When you have deliveries to make – at low cost – do it the modern, progressive way. Use UTILITY ELECTRIC POWER.



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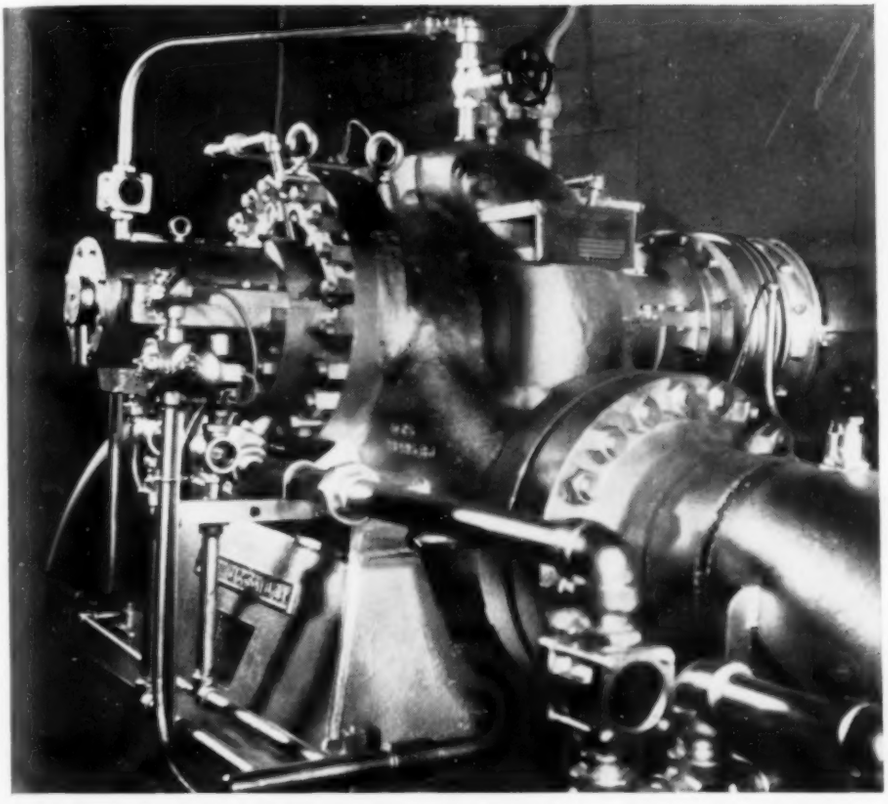
P. O. BOX 35006 DALLAS, TEXAS

NEW HIGH-SPEED BJ PUMPS SMASH PIPELINE PERFORMANCE RECORDS



Boost Trans-Arabian capacity by 25%!

NEW BJ HIGH-SPEED pipeline pumps are proving themselves in rugged, unattended service on the world's largest single long-distance pipeline. Nine BJ centrifugal pumping units, installed on the 1,000-mile trans-Arabian Pipeline, have increased the capacity of the system by 25%—from about 350,000 b/d to 435,000 b/d!

To effect this increase in throughput capacity, five of the BJ Pumps were installed in auxiliary pumping units at isolated locations between existing pumping stations, with a sixth auxiliary unit for a "spare." The other three BJ Pump units were permanently installed. The auxiliary units are mounted on portable vans to permit rotation and periodic overhaul at a central shop. They operate *unattended* and remote-controlled by radio from permanent stations 50 to 100 miles away.

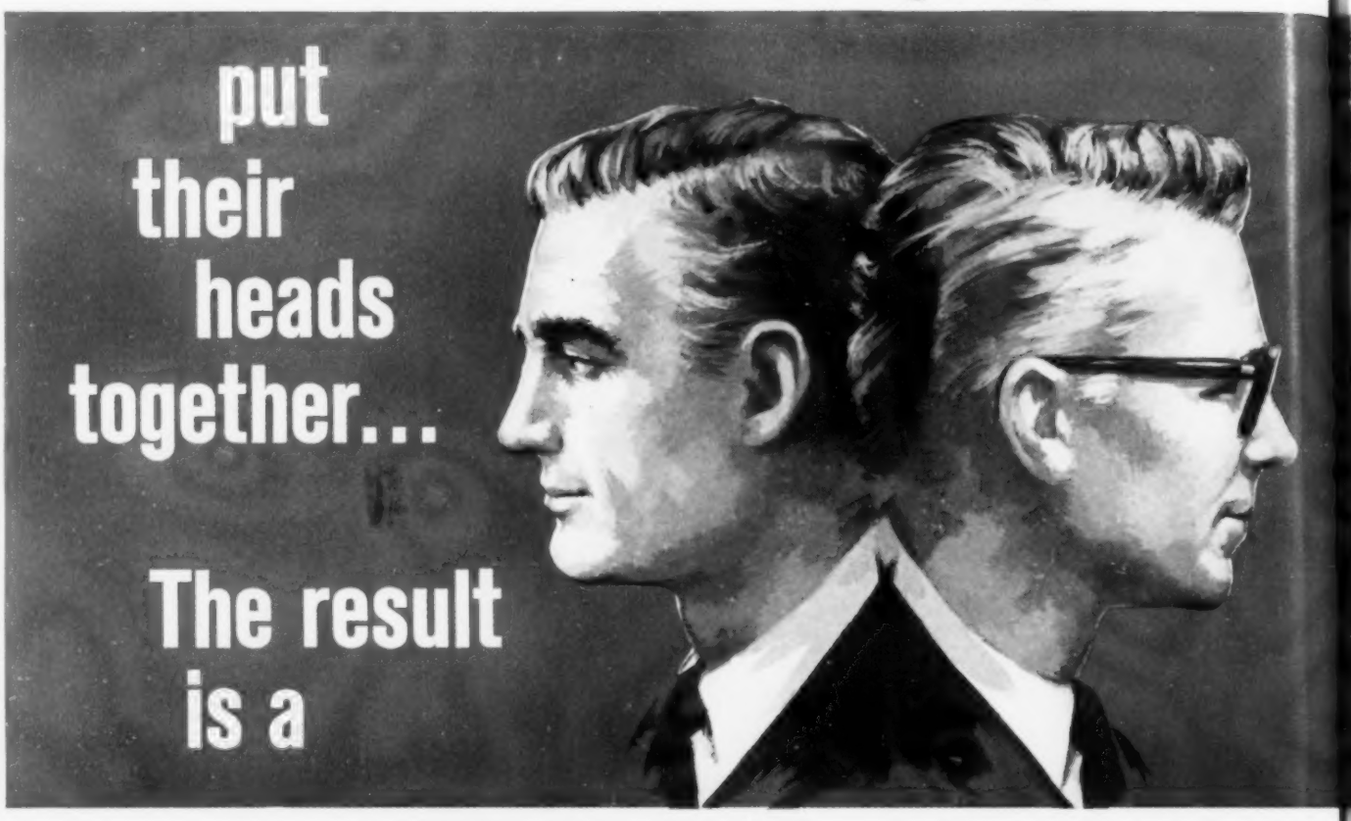
The trans-Arabian Pipeline installations are futher evidence of Byron Jackson's continuing leadership in the design and manufacture of rugged, compact, reliable pumps for the pipeline industry. This experience is available to assist you in finding time-and-money-saving solutions to your pumping problem.

- **NEW HIGHER OPERATING SPEED!**
  Operates at 5250 rpm.
- **NEW GAS TURBINE DRIVE!**
  5,000 HP two shaft combustion gas turbine drive
- **NEW COMPACT DIMENSIONS!**
  Pump is only 5'1" long, 4' wide and 4' high.
- **NEW REDUCED WEIGHT-TO-HORSEPOWER RATIO!**
  Weighs 4650 lbs.—only $^{7}/_{8}$-lb. per horsepower!
- **NEW SIMPLIFIED DESIGN!**
  Rugged single-stage, double-volute, double-suction, end pull out, circular-confined gasket construction with minimum span between bearings for long, maintenance-free operation.
- **NEW INCREASED OPERATING HEAD!**
  Operating head is 1600 ft. For operation near closed valve at overspeed trip setting of 5900 rpm, developed head is 2600 ft.—a new high.
- **NEW HIGHER SUCTION PRESSURE ON START-UP!**
  Unique pump/mechanical seal combination allows 500 lb. suction pressure on start-up, in addition to high developed pressure.
- **NEW LARGER SHAFT DIAMETER!**
  Larger shaft diameter lowers bearing span/shaft diameter ratio to 9.3 with static deflection of less than .003". Unit can be run dry without wear ring damage!
- **NEW STUFFINGBOX RELIABILITY!**
  Pump has BJ Mechanical Seals designed for 500 psi suction pressure.
- **NEW IMPELLER DESIGN—NO WEAR RINGS!**

BYRON JACKSON PUMPS, INC.
A Borg-Warner Subsidiary
BOX 2017-A, TERMINAL ANNEX, LOS ANGELES 54, CALIFORNIA

BJ SINCE 1872

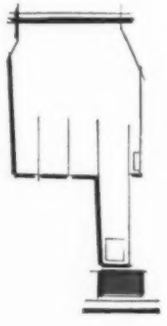
Engineers at Clark and Northern Natural Gas Company

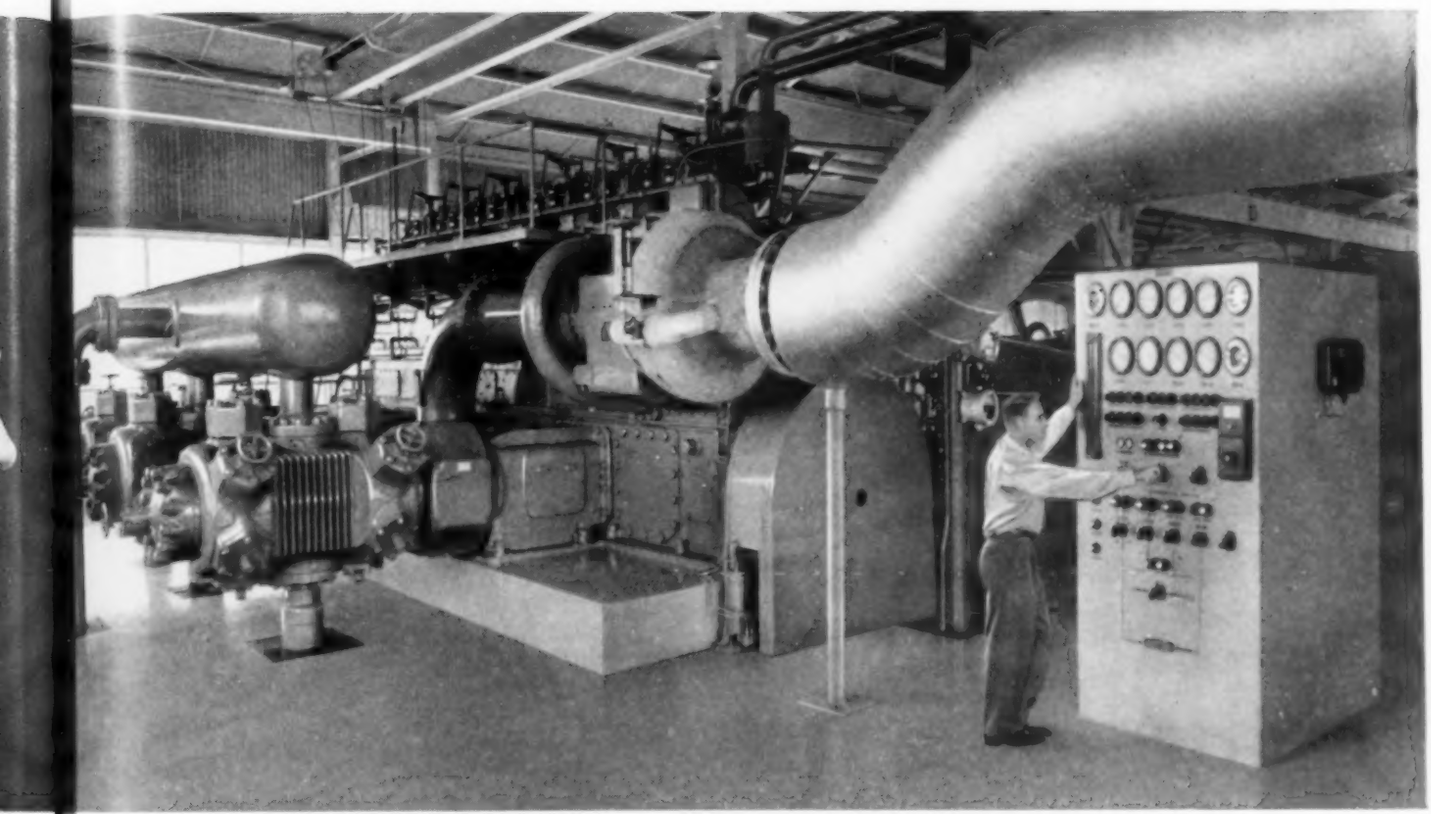


FULLY AUTOMATIC CONTROL

FROM STOP
TO FULL LOAD IN MINUTES!

The Clark-designed Fully Automatic Control Panel starts the engine automatically, allows a warmup period, sequences the valves for purging and blow down, and puts the compressor on line —with a single push of the start button. In case of temperature and pressure malfunction, it will give an alarm signal... and upon continued malfunction, it will shut down the engine and sequence the valves to their off-line position. A single push of a stop button will accordingly remove the unit from service whenever required.





PANEL FOR OPERATING PIPELINE COMPRESSORS!

Problem: Northern Natural Gas Company wanted to centralize and simplify all of the starting and successive functions involved in putting their new Clark TLA-6 Compressor engines on line—in a matter of minutes, with all due safeguards against malfunction.

Solution: Engineers at Clark and Northern Natural Gas Company put their heads together—and off their planning boards came the fully Automatic Control Panel now in successful operation. A simple push of the button sets off an automatic multi-phased starting and warmup operation, with precision timed and preset selections... puts the pipeline compressors on line within minutes ... controls the smooth, uninterrupted compressor service throughout.

This is another example of Clark's expert collaboration with the gas industry in devising ever-better solutions to pipeline problems ... another instance of the value to be derived from the Clark *encyclopedia of experience.* For more facts on how Clark can help you solve compressor problems call your nearby Clark representative. Write today for Bulletin No. 151, to 1604 Lincoln Avenue, Olean, New York.

CLARK BROS. CO.

One of the Dresser Industries

Sales and service outlets in principal cities throughout the world

CLARK®

ONE OF THE DRESSER INDUSTRIES

TURBOCHARGED COMPRESSORS

Along the new highways . . .
ROSKOTE DOES THE JOB WITH SPEED!

Fast drying that permits overcoating or wrapping in a half hour steps up the protective coating phase of new pipeline construction on the jobs where speed is essential — along the nation's new network of highways.

A good example is this 8000 foot stretch of new 8" pipe along the new Southside Expressway in downtown Charleston, W. Va. It was installed recently for the United Fuel Gas Company by Saul and McCallister, Inc., of Yawkey, W. Va.

This contractor found that two men, using the Roskoter for application of Roskote 612 XM cold-applied pipe mastic, could keep pace nicely with the welders. The coating specifications called for over-the-ditch cleaning, two 15 mil applications of Roskote 30 minutes apart, followed immediately by wrapping with 15 lb. perforated asbestos pipeline felt.

Roskote 612XM is a cold-applied, fast-drying pipe mastic of high electrical resistivity. Composed of high grade native pyrobitumens homogenized with quality aromatic solvents and inhibitive pigments, Roskote is also highly resistant to corrosion by acid, alkali and salt. It dries to a tack-free film in 30 minutes or less. It is unaffected by temperature from sub-zero to 250° F. It will not oxidize, scale or check, and it bonds readily to previous coats of Roskote, coal tar or asphalt.

Non-toxic and non-irritant, Roskote may be applied by brush, glove, spray or Roskoter. The latter is seen in use in the photograph.

The Roskoter, one of the simplest means of coating pipe known, is also the most effective. It actually "bathes" the pipe in mastic as an extra safeguard against pinholes and other coating irregularities. And it gets the undersurface and other hard-to-see spots, often missed. Coating with the Roskoter can usually be handled by one man.

Roskote Cold-Applied Pipe Mastic enjoys the confidence of over 400 utilities and pipeline companies. For complete technical data and prices, write your nearest Royston office.

Royston Laboratories, Inc.
Box 112-D, Blawnox, Pittsburgh 38, Pa.

ROSKOTE

BRANCH OFFICES IN ATLANTA, CHICAGO, HOUSTON, PHILADELPHIA, SAN DIEGO AND TULSA. WAREHOUSED IN NORTHEAST, SOUTHEAST, NORTH CENTRAL AND SOUTH CENTRAL REGIONS.

A LEADER IN THE FIELD OF INDUSTRIAL COATINGS FOR CORROSION CONTROL.

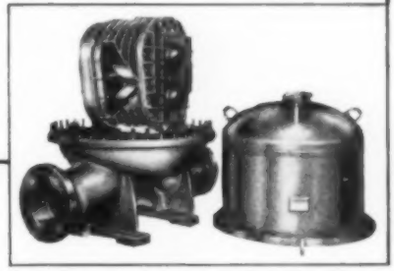
NOW...5000 barrels per hr.

with the new Model B-123 BRODIE *BiRotor* METER

for
- products or crudes
- pipelines
- bunkering
- barge loading
- tanker loading
- refinery runs to stills

Note compactness and full range of sizes of Brodie Meters — from 1¼" to 12" as shown above.

- 12" or 10" flanges or welding ends — pressures to 300 psi
- Compact in-line design for clean installation in new or existing lines
- Sustained accuracy and low maintenance of exclusive *BiRotor* measuring element
- Complete accessibility for inspection, cleaning, or replacement of unit built assemblies without disturbing line connections



Removal of cover dome gives full access for inspection, cleaning and service. The two fluted rotors are the only moving parts with no metal-to-metal contact in the measuring chamber. Friction free ball bearings, counter and timing gears are fully enclosed away from flowing fluid. 801

Years of high capacity services have proved the basic *BiRotor* design handling everything from heavy crudes to high volatiles. Now, the B-123 offers *BiRotor* performance for critical high capacity services up to 5,000 barrels per hour through a single meter. It's available with a choice of counters, printers, and remote counter system to meet every requirement. For the full story, see your Brodie Metering Specialist, or request Bulletin No. 654.

ALL-STEEL BiRotor TRUE ROTARY

BRODIE METERS

RALPH N. BRODIE COMPANY · San Leandro, California, U.S.A.

MT. VERNON, N. Y.	DALLAS 7, TEXAS	CHICAGO OFFICE:	SEATTLE 9, WASH.	LOS ANGELES 22, CALIF.
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REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES

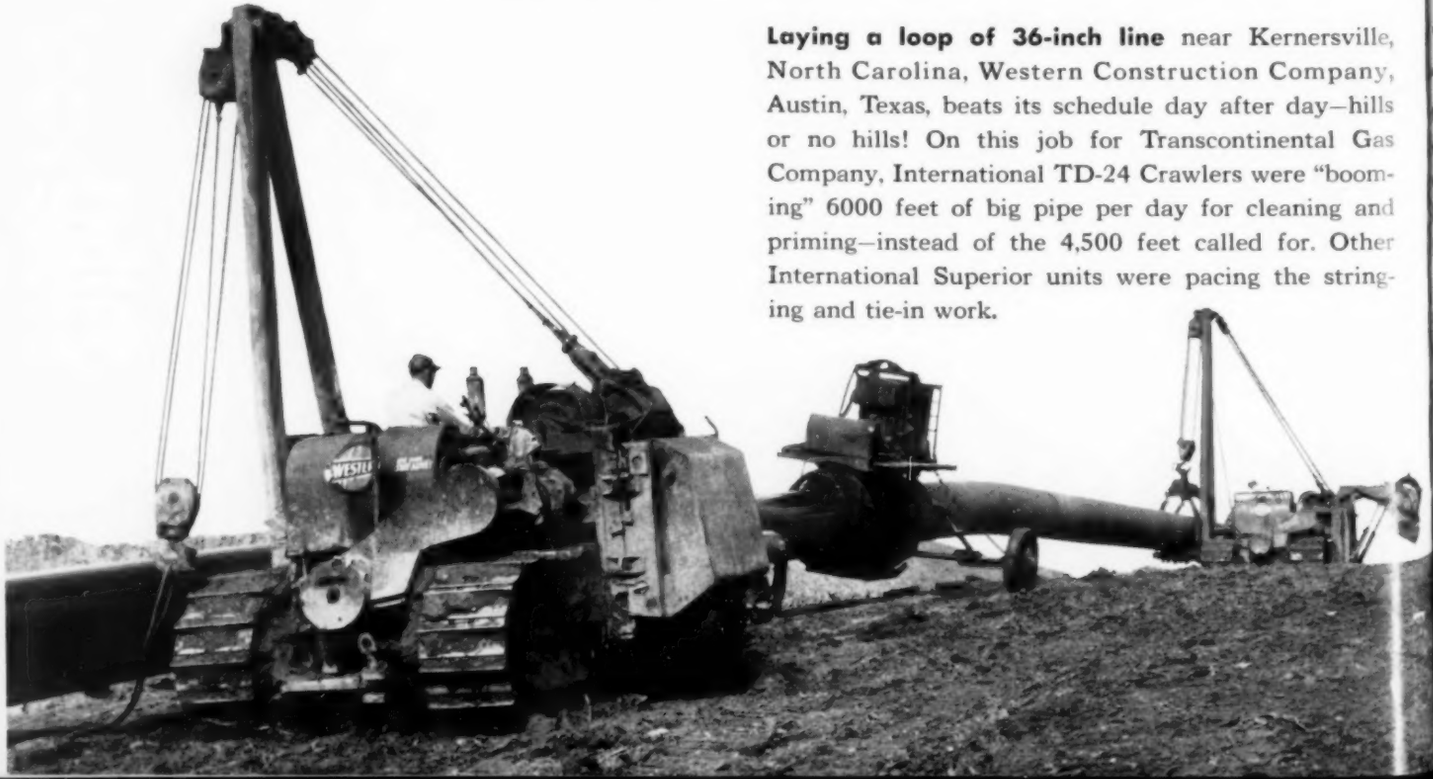
This quick-governing, fuel-thrifty engine on doping detail for Western Construction Company is only one of many International power units on the spread!

Exclusive TD-24 Planet Power steering gives positive, full-time control for precision pipe-handling—upgrade or down. Much line-looping was done on hilly terrain!

Pipeliners in a hurry beat tight schedules

...with Planet Power-

Laying a loop of 36-inch line near Kernersville, North Carolina, Western Construction Company, Austin, Texas, beats its schedule day after day—hills or no hills! On this job for Transcontinental Gas Company, International TD-24 Crawlers were "booming" 6000 feet of big pipe per day for cleaning and priming—instead of the 4,500 feet called for. Other International Superior units were pacing the stringing and tie-in work.



steered TD-24 sidebooms!

"TD-24's are schedule keepers"

"I find dependable TD-24 sidebooms always enable me to maintain the doping schedule, under all terrain conditions," states M. W. Blue, foreman of doping operations. "I like TD-24 Planet Power steering for keeping pipe alignment while carrying, especially in hilly terrain."

For precision pipe-handling control, uphill or down, exclusive TD-24 Planet Power steering lets you feed full-time "live" power to both tracks. You turn smoothly, as sharply or gradually as desired—without jerks! Exclusive TD-24 finger-tip hydraulic braking and foot decelerator give positive pipe-carrying control. And the exclusive TD-24 margin of flotation means bog-beating emergency action traction.

Prove the 130,000 lb. lift capacity—and all the other spread-speeding International Superior TD-24 sideboom advantages. Measure the downtime-prevention value of exclusive wear-saving fleeting sheaves. See your International Superior Distributor for a demonstration!

These two International Superior TD-24 sidebooms have the key assignment of handling big lengths of the 36" pipe for the clearing and doping crew. Operators have the exclusive super-safety and operating ease of reach-easy controls in vertical position.

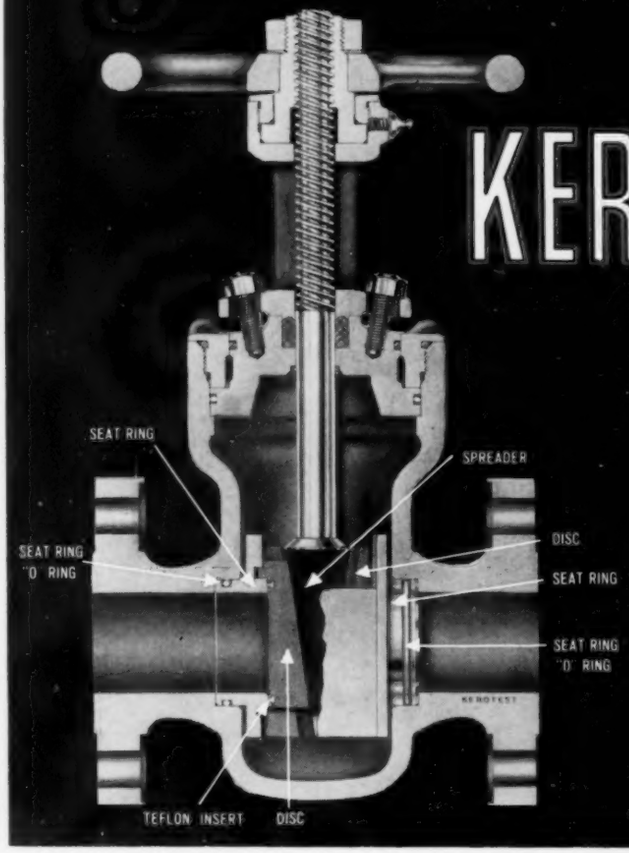
International Harvester Company, Chicago 1, Illinois

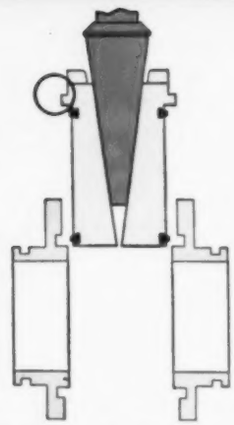
INTERNATIONAL®
SUPERIOR

In Gas, Petroleum or Chemical Industries . . .

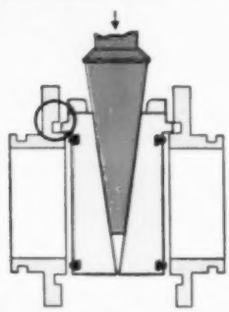
Use the NEW

KEROSEAL® VALVE

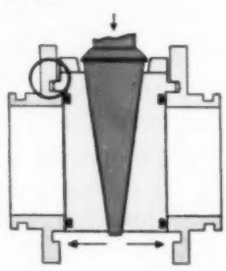




Valve fully open. In closing, discs and spreader move down, perpendicular to flow.



Discs are positioned without drag across seat. When disc lug rests on seat ring, continued downward motion of spreader moves discs parallel to flow.



Valve fully closed. Spreader holds discs vapor-tight against seat rings. When opening, seated discs are retracted with the same parallel motion—again with no drag against seating surfaces. The upward motion does not begin until discs are clear of seat ring.

It's vapor-tight • non-lubricated • optional flow • full opening • double block and bleed

The new vapor-tight, non-lubricated Keroseal Valve offers a revolutionary concept in valve design, embodying advantages not found in any other valve. This Keroseal valve handles liquids and gases in the petroleum and petrochemical industry, as well as a wide variety of fluids in the chemical industry. A vapor-tight seal is effected mechanically without the use of costly lubricants. Wear, frictional drag, wiping and consequent galling of seating surfaces are eliminated by this entirely new principle of valve operation.

For more information on the revolutionary Keroseal Valve, write today for your copy of this full-color bulletin.

KEROTEST

KEROTEST MANUFACTURING COMPANY
2516 Liberty Avenue, Pittsburgh 22, Pa.

In Canada, Kerotest products are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario.

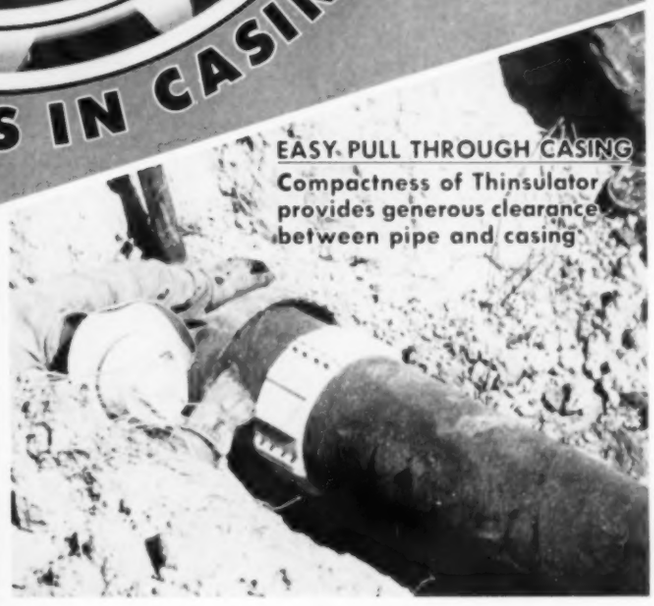
ALL AROUND PROTECTION FOR PIPELINES IN CASINGS

WmSON M-2 PLASTIC THINSULATOR®

For Gathering and Distribution Pipelines

WITH FOUR POINTS OF ADJUSTMENT . . .
THINSULATOR FITS BARE OR COATED PIPE
(4" & smaller have two joints)

EASY PULL THROUGH CASING
Compactness of Thinsulator provides generous clearance between pipe and casing



SIZES: 2" to 12"
(12" sizes shown)

MORE OUTSTANDING FEATURES:

- Tough resilient plastic will not crack
- Extra wide band with ample runners for all around protection and support

T. D. Williamson, Inc.
P. O. BOX 4038 TULSA 9, OKLAHOMA

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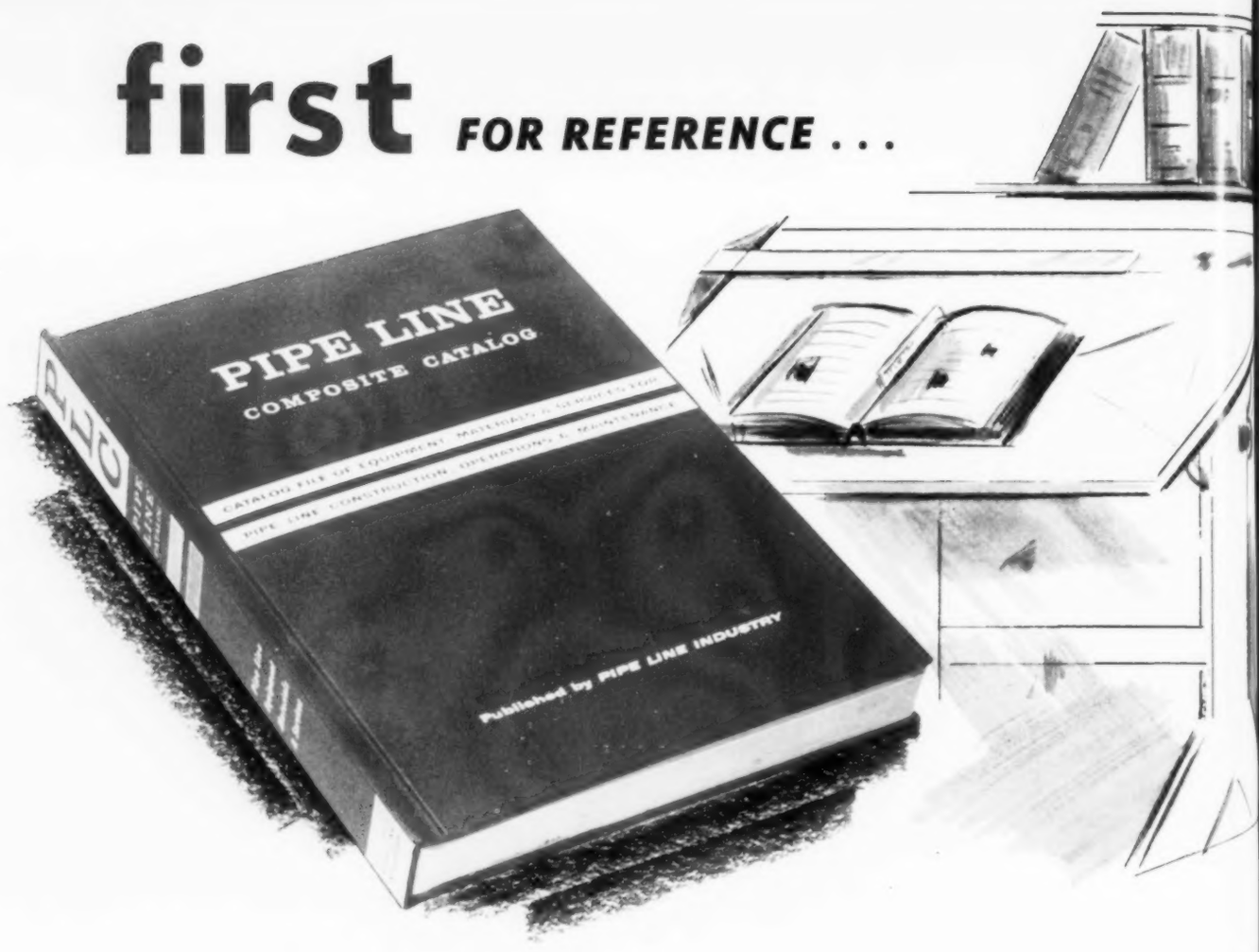

A one-volume reference library for purchasing and specifying. That's the best way to describe the only comprehensive catalog data file published specially for the Pipe Line Industry. Convenient to handle, thoroughly indexed, it is saving time and money for thousands of pipe line men.

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PIPE LINE COMPOSITE CATALOG

Published by PIPE LINE INDUSTRY

P. O. BOX 2608 HOUSTON, TEXAS

Cut Your Trenching Costs With "Teams" of Bucyrus-Eries

Even when the going gets rough, you benefit from the extra output of Bucyrus-Eries. And when *all* the excavators on your spread are Bucyrus-Eries, you have an unbeatable combination. From the ground up, these machines are designed and built to put power to work moving dirt with top efficiency.

It will pay you to find out more about the excavators that are fast becoming preferred from coast to coast for pipe line work. See your nearby distributor today for all the facts.

528E58

BUCYRUS ERIE

A Familiar Sign at Scenes of Progress

SOUTH MILWAUKEE, WISCONSIN

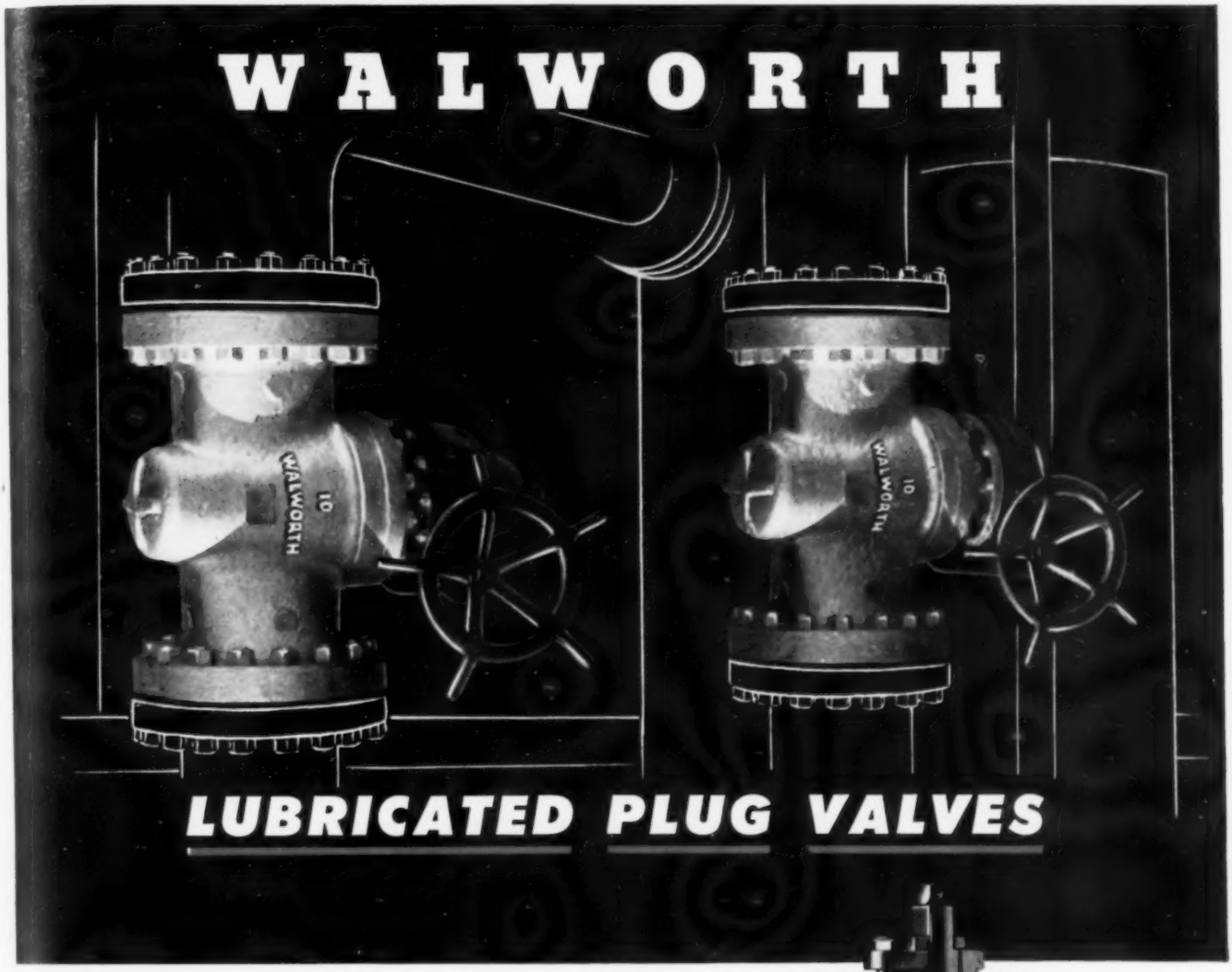
Built for rugged going, these 22-B hoes make a good showing as they trenched for the northern Ontario link of the trans-Canada pipeline. For about 78 miles through rock, mud, clay, and sand, these 22-Bs dug a 6½-ft. ditch. The line runs from the Manitoba border to Ft. William and Port Arthur, Ont. One of the men, who has operated Bucyrus-Eries since 1929, says it has been 15 years since his machine bogged down.

It was tough going for these 22-B hoes working on a 24-in. gas pipeline near Hawley, Pa. They excavated for a river crossing at the bottom of a gorge. Rock, quicksand, and a strong current call for machines that can do the job on schedule. Here, as on trenching jobs around the country, Bucyrus-Erie dependability pays off.

Bucyrus-Erie 22-Bs are fully convertible in the field from hoe to clamshell and other front ends. These clamshells cleaned out a pipeline trench and worked on a road approach in Saskatchewan, Canada. One clamshell is shown moving up as the other digs.

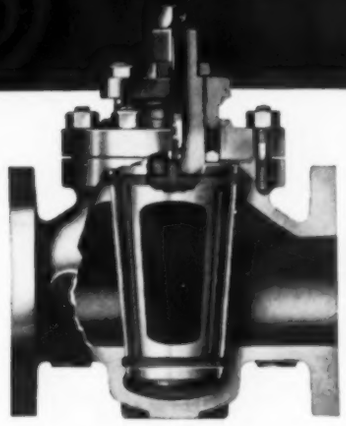
On both sides of the border, Bucyrus-Eries are gaining favor with pipeline contractors because of their ability to perform well under tough conditions. Here a 22-B hoe teamed up with a 22-B dragline to dig trench across the South Saskatchewan River for a 12-in. gas pipeline. The job site is near St. Louis, Sask., Canada.

WALWORTH



LUBRICATED PLUG VALVES

Better because ... They are *pressure sealed* with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.



Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, *Lubricated Plug* Valve. Other Walworth *Lubricated Plug* Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

Walworth Lubricated Plug Valves are the most satisfactory valves available for the handling of gritty suspensions, and many other destructive, erosive, and corrosive industrial and chemical solutions.

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Improve Diesel and Gas Engine Performance!

PEDRICK Piston Ring Sets for diesel and gas engines are "precisioneered" to assure maximum power with minimum oil consumption, to most effectively seal against blow-by, to deliver the greatest number of hours of efficient performance at lowest operational and maintenance costs.

The rings in a PEDRICK "Precisioneered" Set are individually designed to assure users coordinated *team* action. The assembled set is tailor-made for *unitized* action in the specific engine.

That's why PEDRICK Engineered Sets are used as original equipment in practically all leading heavy-duty diesel and gas engines . . . and why when replacement rings are installed, PEDRICK Engineered Sets are specified by most maintenance men.

Complete Sets . . . or open-stock rings, you get improved performance, more economical operation when you specify PEDRICK Piston Rings. And remember, if you have any kind of a ring problem you can count on us to help you solve it. Write, wire or phone: WILKENING MANUFACTURING COMPANY, Philadelphia 42, Pa. SAratoga 9-3770. In Canada: Wilkening Manufacturing Co. (Canada) Ltd., Toronto 2.

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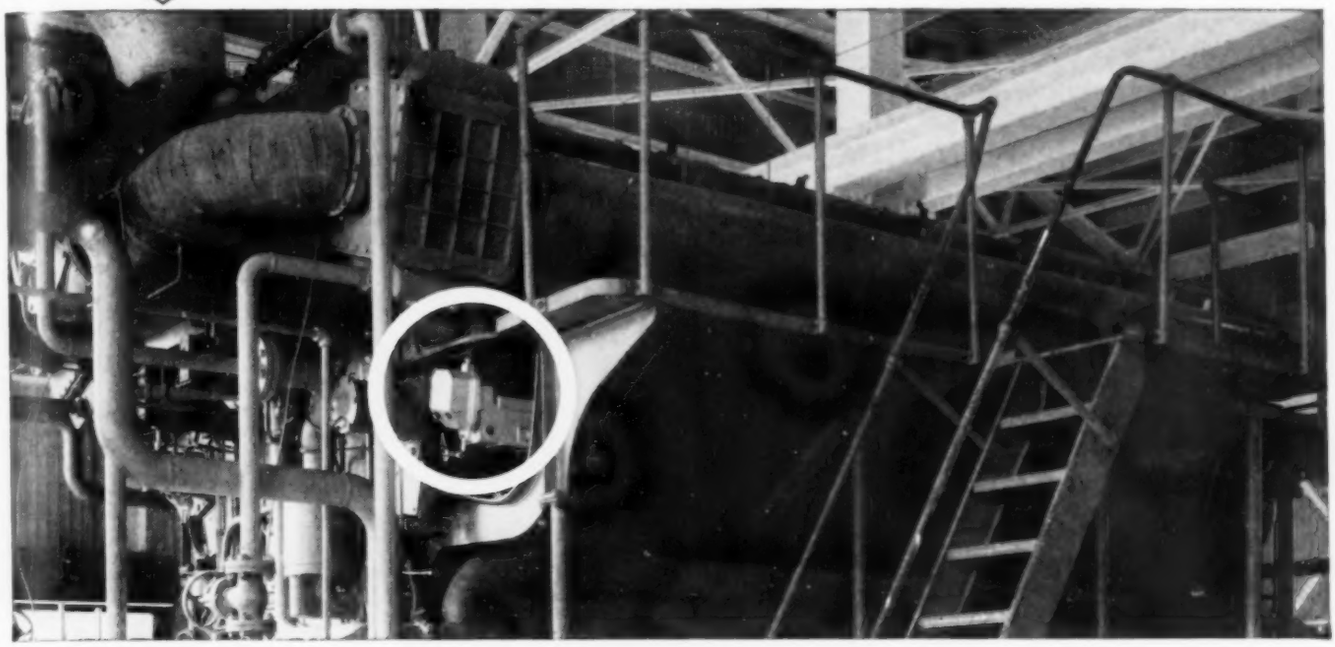
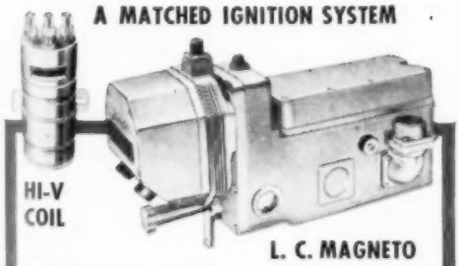


uses Cooper-Bessemer Engines with BENDIX MAGNETOS at their Marcus Hook Refinery!

A MATCHED IGNITION SYSTEM



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11. For engines of 6 through 16 cylinders

Pictured above is a section of the power equipment used by the Sun Oil Company in an ammonia plant at their huge Marcus Hook Refinery.

Typical of Sun's utilization of the most modern equipment in their refining process is this Cooper-Bessemer Model LSV12 engine equipped with Bendix* L. C. Magneto and Hi-V Coil.

Because the Bendix L. C. is a completely new type of magneto, it incorporates the latest developments in engineering, design and production techniques. The result is a matched ignition system—L. C. Magneto plus Bendix Hi-V transformer coils—that delivers more than ample voltage with greatly reduced maintenance costs.

That's why whenever top performance is a must, you'll find more and more important operators making the new Bendix L. C. Magneto their choice.

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For more data on advertised products, use Readers' Service Cards, last page.

C. E. Williams, Gulf Sales Engineer, Midland, Texas, and G. W. Ramsey, Assistant Plant Superintendent, inspect force feed lubricators on one of the modern gas engines at the Goldsmith plant of El Paso Natural Gas Company.

No lubrication problems in 8 years of operation

Since 1949, twenty-seven gas engine-compressor units developing 39,985 horsepower at the Goldsmith plant of El Paso Natural Gas Company have been thriving on Gulf Security Oil. Bearing, ring and cylinder wear maintenance records have been excellent.

Insure safe, more effective lubrication protection for *your* compressor units. Specify Gulf Security . . . the high quality, straight mineral oil. For full information, call your nearest Gulf office.

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2 new ALLIS-CHALMERS DIESELS

D-516
131 brake hp at 1800 rpm

D-344
88 brake hp at 1800 rpm

. . . with

THEY'RE ALIVE WITH WORK-POWER AT SPEEDS YOU CAN USE!

These two completely new Allis-Chalmers diesels give you real *Do-More Power* — high-torque power that puts maximum turning effort on a shaft at the "bread and butter" speeds you actually use. They are smooth, steady, responsive to give you more profitable performance wherever you use them.

Follow-through combustion results in top fuel economy, lower operating costs.

BRIEF SPECIFICATIONS	D-344	D-516
Piston displacement, cu in	344	516
Bore and stroke	$4^{7}/_{16} \times 5^{5}/_{16}$	
Cylinders	4	6
Maximum bare engine horsepower (at 1800 rpm)	88	131
Power unit horsepower (at 1800 rpm)	79	122
Maximum torque at rpm	278 @ 1000	392 @ 1300
Fuel	No. 2 Comm. Diesel	
Types	Fan to flywheel engines Open or closed power units.	

Strength flows from end to end through husky, forged steel crankshaft.

Positively controlled cooling and lubricating works wonders with efficiency and engine life.

4-cycle simplicity fortifies your work-power, gives you more for your engine dollar.

Built-in safeguards provide protection, help assure dependable performance.

Ruggedness throughout means bonuses in long life, more operating hours per dollar.

Call your Allis-Chalmers engine dealer. Get the complete story on these and other Allis-Chalmers *Do-More Power* engines — 9 to 516 horsepower; operating on diesel fuel, gasoline, LP or natural gas.

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ENGINE - MATERIAL HANDLING DIVISION,
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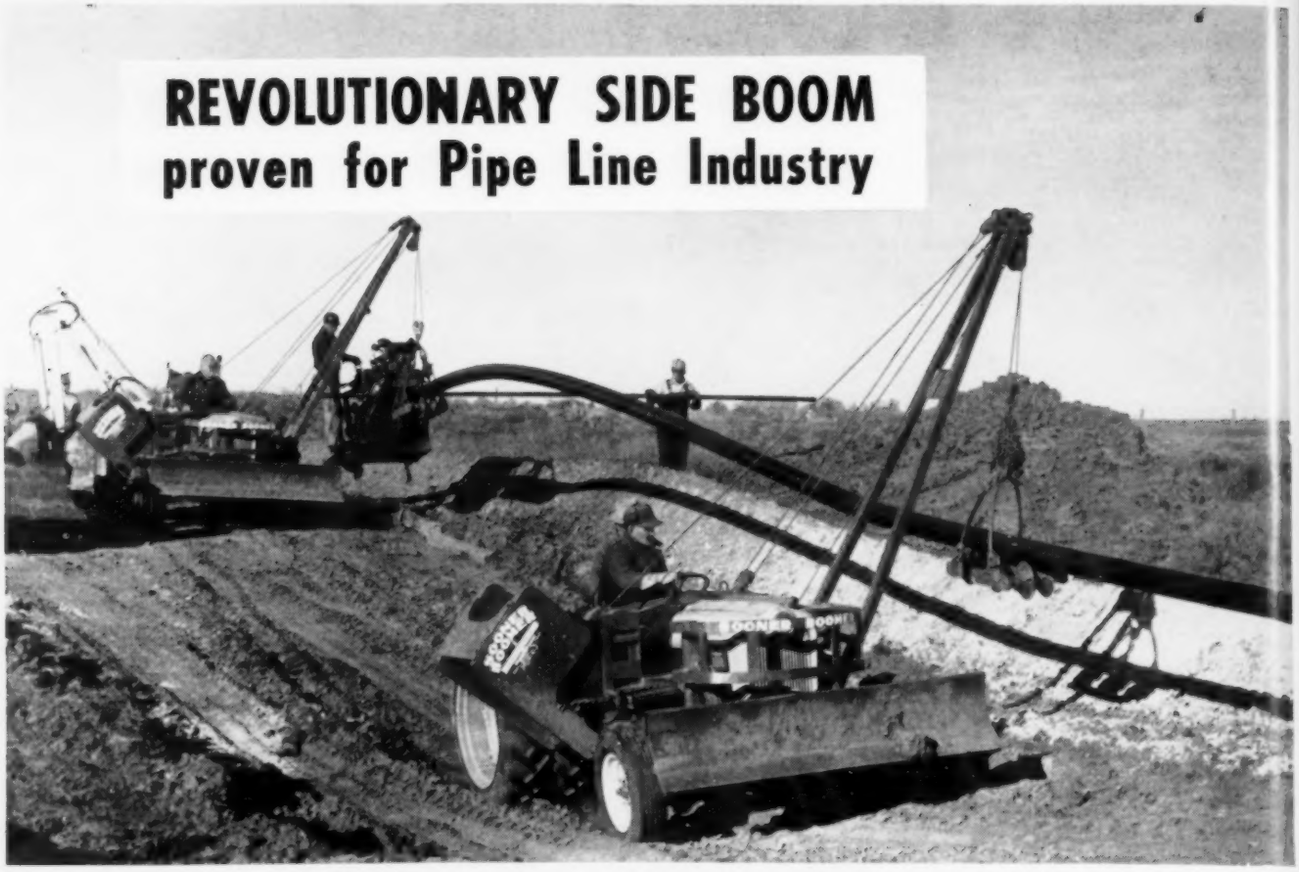
REVOLUTIONARY SIDE BOOM
proven for Pipe Line Industry



The Only Side Boom Mounted On Rubber Tires!

Rubber Tire Mounted
SOONER BOOMER
Handles 10-inch Pipe!

LOW-COST SOONER-BOOMER DOES THE WORK OF 2 CONVENTIONAL MACHINES!

The Sooner-Boomer is the world's first side boom mounted on rubber tires. Designed to handle 10" pipe, this revolutionary machine eliminates unnecessary right-of-way damage on city work—eliminates the need of pipe stringing along city streets ahead of ditch. A low center of gravity makes the Sooner-Boomer highly stable, loaded or unloaded. It operates at road speeds on back haul, and is equipped with a swamper platform. A 12-foot boom makes it possible to lower in over spoil. Power up and power down on all cables assures ultimate safety and precision line-up. The Sooner-Boomer easily lowers in or bends 8-inch pipe. Excellent performance on clean-up and ditch dressing. The Sooner-Boomer is designed to put all weight on wheels, eliminating any strain on engine, transmission and differential.

OPTIONAL: 7 foot angle dozer; rear-end winch; 8 forward and 2 reverse speed transmission; trailer hitch; 3-pin connected, boom mounted bending shoe (available in 2, 4, 6 and 8" sizes).

LIFTING CAPACITY	8 Ft. Radius 2450 lbs. plus
4 Ft. Radius 3750 lbs. plus	10 Ft. Radius 1500 lbs. plus

USING FORD SERIES 600 AND SERIES 800 TRACTORS

Check These Features

- **Mounted On Rubber Tired Tractor!**
- **Power Steering!**
- **Highly Maneuverable!**
- **Road Speed up to 27 MPH!**
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- **All-Hydraulic Operation!**
- **Hydraulic Controlled Counter Weights!**
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- **12-Foot Boom Handles 10" Pipe!**
- ***Lowest Initial Cost!***
- ***Lowest Operating Cost!***
- **Six months warranty from date of purchase on tractor and SOONER BOOMER!**

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MFG. DIV.

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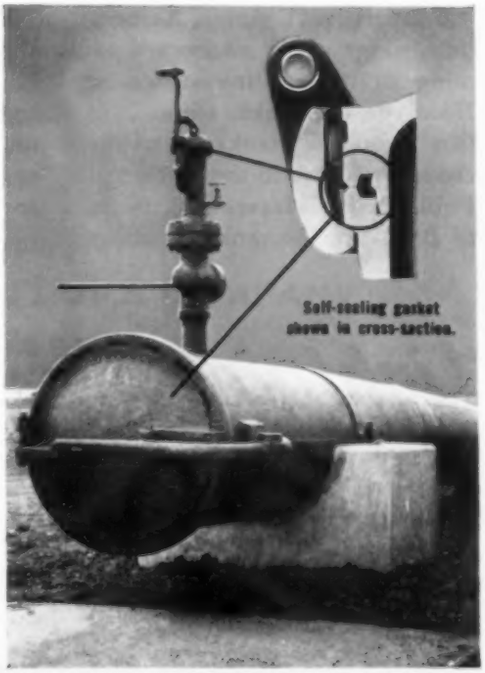
If you are a pipeliner

you'll appreciate this self-sealing gasket in UNIBOLT scraper trap and blowdown closures

Little things . . . like the gasket for a scraper trap or blowdown closure for example . . . can be a big headache. But not this one. It is the self-sealing gasket used in UNIBOLT pipeline couplings. The UNIBOLT design makes line pressure do the sealing. And this design practically encloses the gasket in steel so that when the closure is opened and closed the gasket is hardly disturbed. Made of oil- and gas-resistant Hycar nitrile rubber, this gasket will last indefinitely under normal conditions.

UNIBOLT scraper trap and blowdown closures are hinged for easy operation. Release only two bolts and the closure swings open and shut like a door. No heavy lifting. No time-consuming multi-bolt flanges. See our detailed data in Pipe Line Composite Catalog and write or wire for any needed information.



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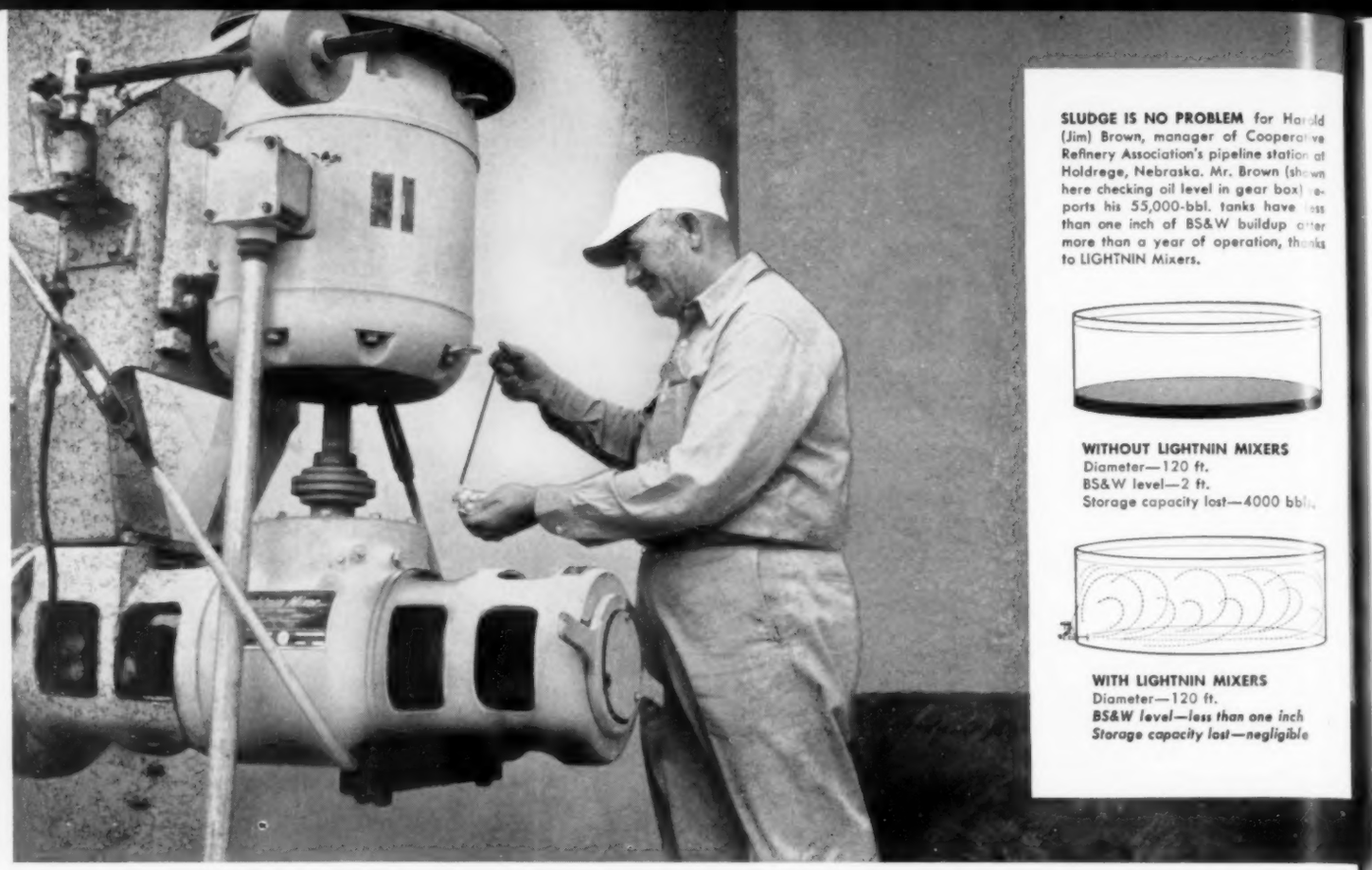

SLUDGE IS NO PROBLEM for Harold (Jim) Brown, manager of Cooperative Refinery Association's pipeline station at Holdrege, Nebraska. Mr. Brown (shown here checking oil level in gear box) reports his 55,000-bbl. tanks have less than one inch of BS&W buildup after more than a year of operation, thanks to LIGHTNIN Mixers.

WITHOUT LIGHTNIN MIXERS
Diameter—120 ft.
BS&W level—2 ft.
Storage capacity lost—4000 bbl.

WITH LIGHTNIN MIXERS
Diameter—120 ft.
BS&W level—less than one inch
Storage capacity lost—negligible

Is sludge hogging your tank capacity?

Cooperative Refinery Association cleans tanks by flipping a switch. So can you.

Sludge is a tank hog. It eats up valuable tank capacity you badly need for crude. It's a messy tenant, too, and cleaning up after it is a costly, dirty job.

Rid your tanks of sludge, and you add as much as 12% more capacity to your pipeline stations.

Cooperative Refinery Association brings crude oil from Wyoming to its pipeline station at Holdrege, Nebraska, stores it in two 55,000-bbl. tanks. When the crude moves on to the refinery at Phillipsburg, it leaves a minimum of BS&W in the tanks. In more than a year of operation, scarcely an inch of sludge has accumulated in either tank.

Simple method pays off

Secret? Cooperative Refinery Association equipped each tank with a LIGHTNIN Side Entering Mixer. When temperature falls below 70°, these mixers go to work for about four hours a day. They keep bottoms stirred, prevent oil from congealing. When the oil moves on, each tank is ready to take on a new supply—without cleaning—and at full capacity.

LIGHTNIN Mixers are keeping storage tanks free of sludge at many pipeline stations, increasing storage capacity, eliminating downtime for cleaning, making every barrel in every tank merchantable crude oil.

Here's why you can't lose

You take no risk when you order a LIGHTNIN. Every one is unconditionally guaranteed to perform its job—or your money back.

Learn how LIGHTNINS can solve your sludge problems, make your tanks work harder, cut your costs. Call in your LIGHTNIN representative, or write us today.

Lightnin® Mixers

MIXCO fluid mixing specialists

Get these helpful facts on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with name and company address. Free—no obligation.

- ☐ B-503 Illustrated bulletin on BS&W control
- ☐ B-104 20-page catalog fully describing LIGHTNIN Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-110 Condensed Catalog describing LIGHTNIN Mixers of all types
- ☐ B-111 Bulletin describing LIGHTNIN rotary mechanical seals for extra-low-cost mixing

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Positive remote supervisory control of pump motors and valves

Two complete packaged remote control systems are now available for application to distant motor operated valves and electric pump motors. Gardtrol Valve and Pump Motor Monitors provide constant monitoring and positive, non-ambiguous indication of "on", "off", "open", "closed" and "stopped" conditions at remote stations. Both units feature simplified design—three components, a control unit, field unit and single wire transmission line provide efficient, economical controlling. Exclusive Gardtrol circuit utilizes the cyclically-reversing polarity of alternating current to effect both control and supervision over one wire. Distance is limited only by the resistance of the signal wire.

two packaged units

GARDTROL VALVE MONITOR
opens, closes or stops valves in any position

GARDTROL PUMP MOTOR MONITOR
indicates off, on, and stops motors

Call or write your nearest Shand and Jurs office for specifications and prices.

SHAND AND JURS GENERAL PRECISION EQUIPMENT CORPORATION GPE

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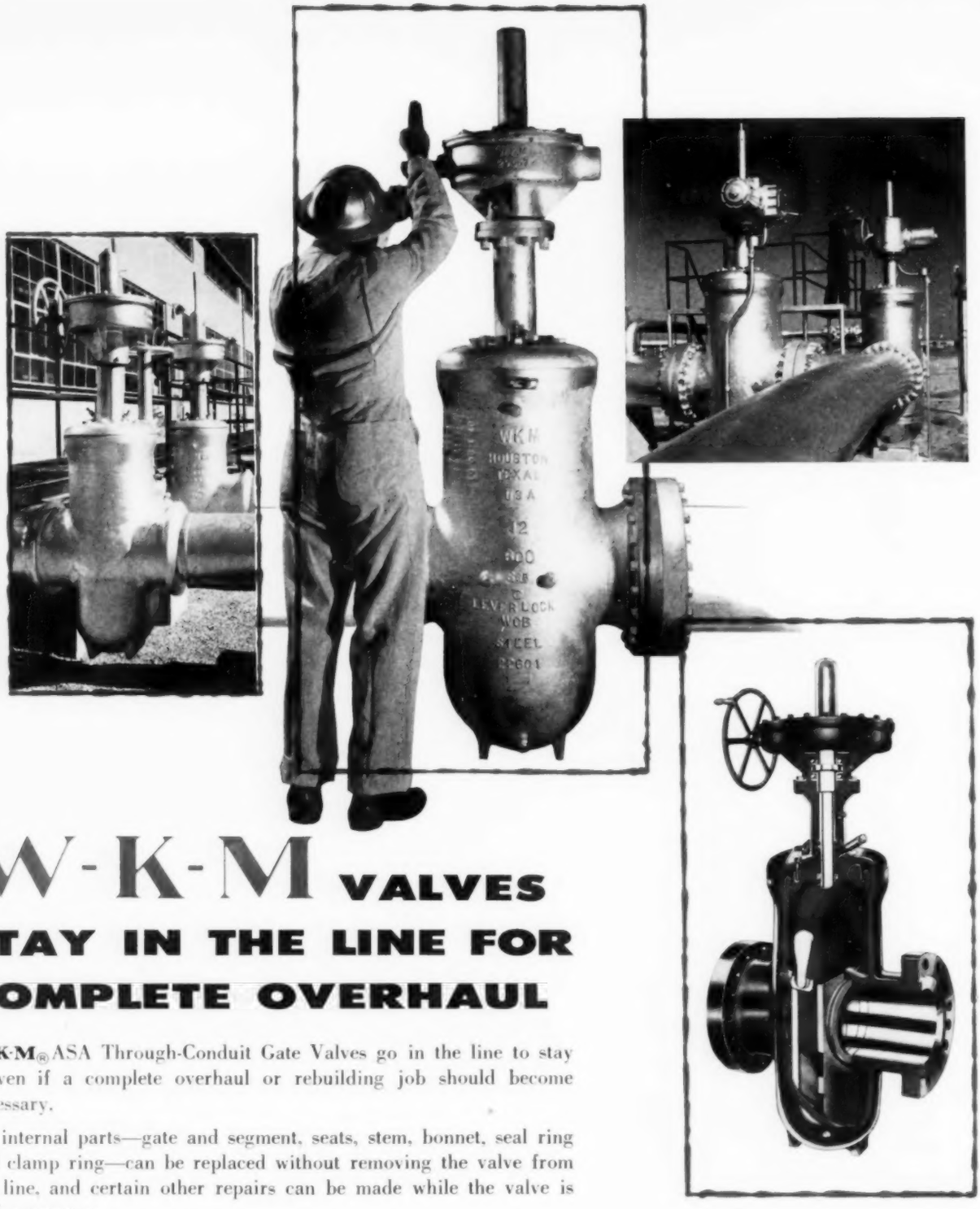

W-K-M VALVES

STAY IN THE LINE FOR COMPLETE OVERHAUL

W-K-M® ASA Through-Conduit Gate Valves go in the line to stay —even if a complete overhaul or rebuilding job should become necessary.

All internal parts—gate and segment, seats, stem, bonnet, seal ring and clamp ring—can be replaced without removing the valve from the line, and certain other repairs can be made while the valve is *under pressure.*

Precise engineering and manufacture of **W-K-M** valves reduce maintenance to a minimum. But when repair needs do arise, costs stay low—because **W-K-M** valves stay "in the line."

***W-K-M** ASA Through-Conduit Valves are available in sizes 2" through 30"—ASA 300 lbs. to ASA 900 lbs. Valves up to 12" are available through supply stores.*

W-K-M is a registered trademark of ACF Industries, Incorporated.

Bring your valve reference library up-to-date by writing Dept. J-5 for new W-K-M ASA Through-Conduit Gate Valve Catalog 300.

W-K-M

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PIPE LINE PANORAMA

Texas Oil Leaders Express Pipe Line Views . . . Two of Texas' top oil statesmen recently expressed their opinions on the future of the pipe line industry:

Said Texas Railroad Commissioner Ernest O. Thompson: Most pressing need today is pipe line from Texas to West Coast—for national security reasons. "The steel mills have idle capacity to make the pipe, and construction would help bring us out of this so-called recession."

Said Commissioner Bill Murray: Texas pipe line companies can expect the Railroad Commission to make broader use of its authority concerning oil well connections. He gave strong hint that a specific code on connections may be forthcoming in near future. Thus, indications are that Commission has made some form of decision on recent hearing in which operators claimed there were 8,000 Texas wells without connections to pipe line outlets.

What's New in Pipe Line Technology . . . A mobile gas analyzer which permits detection of methane from car traveling 20-40 miles per hour promises to sharply reduce costs of leak detection work on transmission and distribution lines. Now undergoing final field tests, the device is reportedly 50 times more sensitive than equipment now in use. Unit is infrared analyzer powered by 6-volt battery mounted in back of car—picks up gas samples through hollow probes attached to front bumper —produces an audible sound when methane is detected.

Newly developed portable current division tube tester increases reliability of microwave operation, decreases tube replacement costs. (See Page 44.) A small replica of larger instrument used by tube makers for quality control for several years, the device tests tubes with too large a rating for conventional tube checkers—permits service men to predict imminent tube failure and determine whether tube will operate satisfactorily until next service call. Tester was recently used on several hundred discarded 2C39 tubes (cost $22-$32 each). Result: many were classified as operable.

Depends on Whom You Talk to . . . In mid-April, Tennessee Gas Transmission announced 40 percent cutback in expansion plans approved by F.P.C. Reason: Memphis Decision has forced company to ask customers for new agreements to proposed rate hikes—some have refused. Estimated cost of Memphis Decision to pipe line industry if not reversed by Supreme Court: $217 million now—millions more later.

On the other hand, several pipe line companies recently announced major construction plans:

- Southern Natural Gas Company has asked F.P.C. for green light to start 18-month, 1,200-mile gas pipe line program (Cost: $110 million) to gather gas from nearly 35 new fields in south Louisiana and Gulf of Mexico for delivery to Alabama, Georgia, Mississippi and South Carolina.
- Natural Gas Pipe Line Company is awaiting F.P.C. approval to start $87 million program that will increase gas deliveries to Chicago area by 185 million cubic feet per day. Project includes 232 miles of 36-inch line between Beatrice, Neb., and Joliet, Ill., plus 258 miles of 36-inch line and 21 miles of 26-inch line between Texas Panhandle and Beatrice. This is modification of previously announced Beatrice project.
- Transwestern Pipe Line has asked F.P.C. for authority to build 1,305-mile line from gas producing areas of West Texas and Texas-Oklahoma Panhandle to California-Arizona border. Cost: $193 million. Capacity: 350 million cubic feet per day.

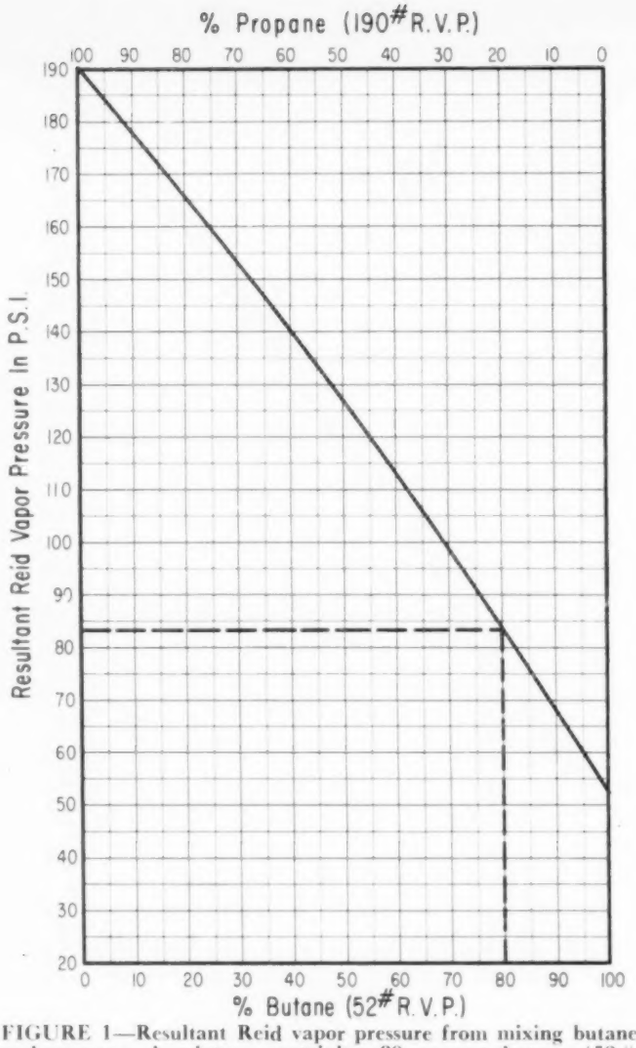


FIGURE 1—Resultant Reid vapor pressure from mixing butane and propane. A mixture containing 80 percent butane (52# Reid vapor pressure) and 20 percent propane (190# Reid vapor pressure) would have a vapor pressure of 83.3 psi.

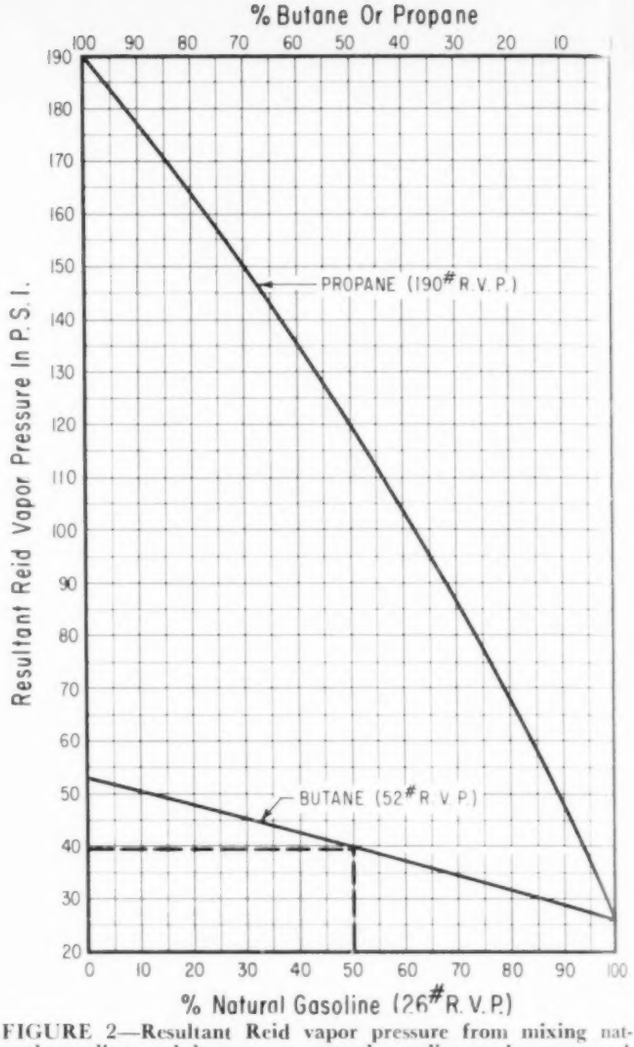


FIGURE 2—Resultant Reid vapor pressure from mixing natural gasoline and butane or natural gasoline and propane. A mixture containing 50 percent natural gasoline (26#R.V.P.) and 50 percent (52#R.V.P.) would have a vapor pressure of 39.9 psi.

Graphs Solve NGL-Crude Blending Problems

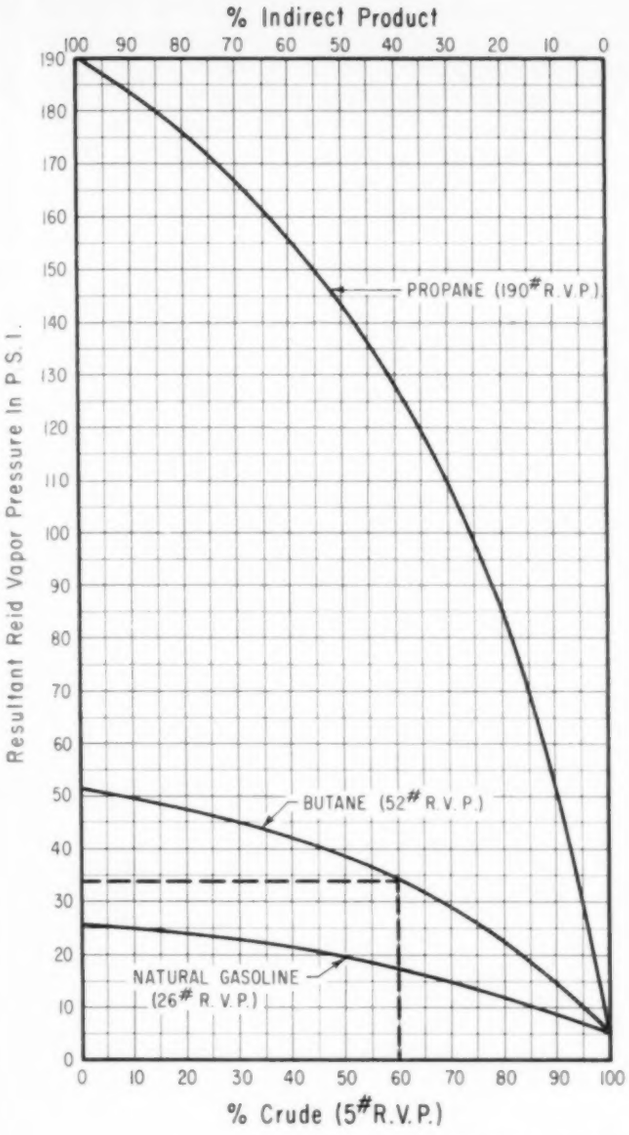
The resultant Reid vapor pressure for mixing crude and natural gas liquids can be read directly from graphs, saving time and reducing errors.

By R. J. Evans
Texas Pipe Line Company
Houston

DURING THE past decade, the domestic production of natural gasoline and liquefied petroleum gas products has increased from 362,000 to 805,000 barrels per day. In the same period these natural gas liquids have developed from 6.9 percent of the total production of crude and NGL to 9.8 percent. Conservation practices and rising demand for the products for fuel and blending with gasoline have provided the incentive for this increase.

The increase in production has made new demands upon the industry for transporting the products to refineries and to the consuming areas of the country.

Tank cars and trucks for long hauls are expensive and often price the products out of the market at the destination. Some areas have enough production to justify the use of a pipe line exclusively for natural gas liquids. Other producing areas can utilize existing products pipe lines to carry the NGL products. In this case the volatile products are batched through the line with the normal refined crude products.


% Indirect Product
100 90 80 70 60 50 40 30 20 10 0
Resultant Reid Vapor Pressure In P.S.I.
PROPANE (190# R.V.P.)
BUTANE (52# R.V.P.)
NATURAL GASOLINE (26# R.V.P.)
0 10 20 30 40 50 60 70 80 90 100
% Crude (5# R.V.P.)

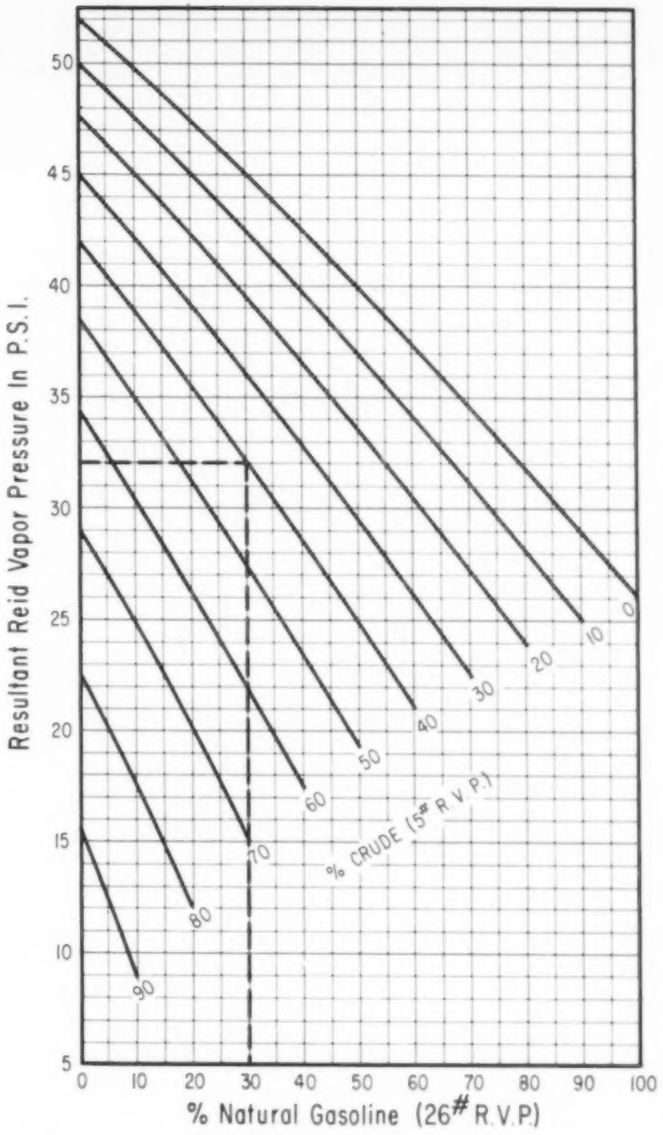


FIGURE 3—Resultant Reid vapor pressure from mixing crude and various indirect products. A mixture containing 60 percent crude (5#R.V.P.) and 40 percent butane (52#R.V.P.) would have a vapor pressure of 34.0 psi.

FIGURE 4—Resultant Reid vapor pressure from mixing crude, butane, and natural gasoline. A mixture containing 30 percent natural gasoline (26#R.V.P.), 30 percent butane (52#R.V.P.), and 40 percent crude (5#R.V.P.) would have a vapor pressure of 32.1 psi. Percent butane equals 100 percent less percent natural gasoline and crude.

Blending with Crude. One of the transportation facilities that is being used increasingly for carrying natural gas liquids is the crude oil pipe lines. In at least one case the NGL products are batched through the pipe line between crude oil batches. It is more common, however, for the NGL liquids to be blended with the crude. The objection to this method in the past was that refineries were unable to handle the mixture. However, a number of refineries now have facilities for taking care of volatile mixtures.

Vapor Pressure Problems. Using crude as a vehicle for carrying NGL products has created a number of problems for the pipe line industry. Most of the difficulties are a result of the volatiles raising the vapor pressure of the mixture.

If by blending the crude and NGL,

TABLE 1

	Average Crude	Natural Gasoline	Normal Butane	Total
[1] BPD	28,000	6,000	6,000	40,000
[2] Volume Percent	70.0 (8.33) (.835) (70)	15.0 (8.33) (.628) (15)	15.0 (8.33) (.584) (15)	100.0
[3] Method of Calc. Lb. Moles	210	73.4	58.1	
Lb Moles	2,317	1,069	1,258	4,644
[4] Mole Percent	49.892	23.019	27.089	100.0
[5] RVP of Component	5.0	26.0	52.0	
[6] Partial Vapor Press.	2.495	5.985	14.086	
[7] Total RVP				22.566

The method of calculating each of these steps is shown below:

[1] Barrels Per Day: Given.

[2] Volume Percent = $\frac{\text{BPD of Component}}{\text{Total BPD of Mixture}}$

[3] Lb. Moles = $\frac{(\text{Wt. of Gal. of Water}) (\text{Sp. Gr. of Component}) (\text{Vol. \%})}{\text{Molecular Wt. of Component}}$

[4] Mole % = $\frac{\text{Lb. Moles of Component}}{\text{Total Lb. Moles}}$

[5] RVP of Component: From handbook or test.

[6] Partial Vapor Press. H Mole % x Reid Vapro Pressure of Component.

[7] Total RVP = Sum of Partial Vapor Pressures.

the vapor pressure of the mixture is below atmospheric, tank losses are still increased considerably. This is particularly true of filling losses. For instance, a fluid with a vapor pressure of 3.5 pounds per square inch would have a filling loss of approximately 0.1 percent of the throughput in a cone roof tank. Whereas a fluid of 10 psi vapor pressure would experience a filling loss of about 0.3 percent in the same type tank. For this reason pipe lines usually schedule their crude-NGL shipments so that the storage in transit is kept to a minimum.

If the vapor pressure of the mixture is greater than atmospheric, normal storage facilities can't be used. Since pressure storage is very expensive, this usually means tight line operation from point of blending to the refinery.

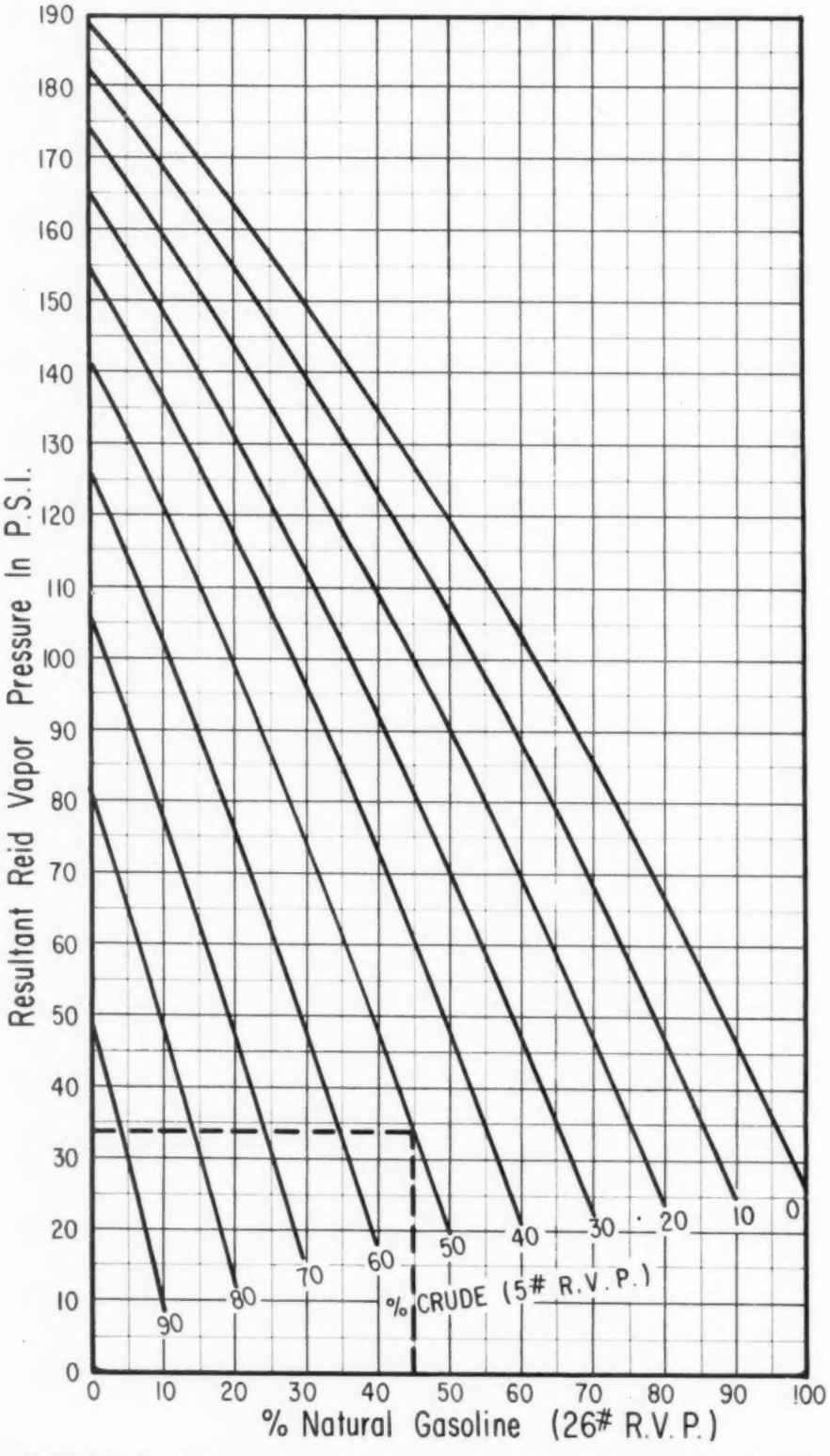


FIGURE 5—Resultant Reid vapor pressure from mixing crude, natural gasoline, and propane. A mixture containing 45 percent natural gasoline (26#R.V.P.), 50 percent crude (5#R.V.P.), and 5 percent propane (190#R.V.P.) would have a vapor pressure of 34.3 psi. Percent propane equals 100 percent less percent natural gasoline and crude.

Special Pumping Precautions. When pumping volatile mixtures it is necessary to maintain sufficient back pressure at booster stations to keep the mixture from vaporizing in the line. Even on mixtures below atmospheric pressure, adequate net positive suction head for main line or suction booster pumps may become a problem. Pressure gradients of the line must also be checked to see that the mixture will not vaporize on hills.

The hydraulics of the line need to be reviewed because the pressure head produced by centrifugal pumps is not as great with the lower specific gravity of the fluid. Engine-driven pumps can be speeded up to compensate for the loss in head. However, this is not possible with electric motors as the prime movers. The combination of reduced pump head and need for increased suction pressure at booster stations combine to reduce the capacity of the line. This is at least partially offset by the crude being made less viscous with the addition of NGL products.

There is a greater opportunity for hazardous vapors to escape from pumps when handling high vapor pressure, low viscosity mixtures. The lubricating quality of crude is reduced by the addition of NGL products and therefore reduces the effectiveness of conventional pump packing. For these reasons, centrifugal pumps with mechanical seals are generally considered necessary for safety.

In reviewing the problems created by the mixture of NGL and crude, it becomes apparent that the measurement and calculation of the vapor pressure of a mixture is important.

Measuring Vapor Pressure. In the oil industry, vapor pressure is usually measured by the Reid method. Reid vapor pressure is measured in pounds per square inch absolute at 100° F. in a bomb that allows some vapori a-

tion of the product being tested. Therefore, RVP is slightly lower than the true vapor pressure at 100° F. except in the case of a pure component. Partial vaporization of a pure component does not change the composition of the unvaporized portion.

Calculating Vapor Pressure. The method of calculating vapor pressure of a mixture is based on the partial vapor pressure of each component being proportional to the mole percent of that component. Some will recognize this as Raoult's law and know that it has limitations. At pressures above 65 psia, the results obtained by this method are not extremely accurate. However, for the normal pipe line operating problems the results are acceptable. The method of calculation will usually be more accurate than field measurement of the components in the mixture.

The procedure might best be shown by an example of mixing an average crude, natural gasoline, and normal butane as shown in Table 1.

Constant Provides Short Cut. Often the operating conditions of a line are such that the percentages of the components are changing frequently. If a calculation of the vapor pressure is made for each change, the mechanics can be very time consuming.

Use of a constant will reduce the time required for calculations. In calculating "pound moles" in Step (3), everything remains constant for any given component, except volume percent. So the constant for one component of a mixture becomes

$$\frac{\text{(Wt. of Gal. of Water) (Sp. Gr. of Component)}}{\text{(Molecular Wt. of Component)}}$$

This constant may be multiplied by the volume percent to obtain the pound moles of the component. Table 2 lists a number of common crudes and NGL products. For each of these the specific gravity, Reid vapor pressure, molecular weight, and mole constant are given. The figures for crude and natural gasoline are approximate.

Graphical Solution Convenient. If the mixture of hydrocarbons contains no more than three components, a graph can be compiled to give the vapor pressure. By knowing the volume percent of each of the components, the vapor pressure of the mixture may be read on the graph.

Figures 1 through 7 are presented here. These cover any two or three component mixture made from an average crude, 26# natural gasoline, normal butane, or propane.

Figures 1, 2 and 3 are for a two component mixture and are simple curves. The chart is entered at the bottom with the volume percent of one component. The vapor pressure of the mixture is then read opposite

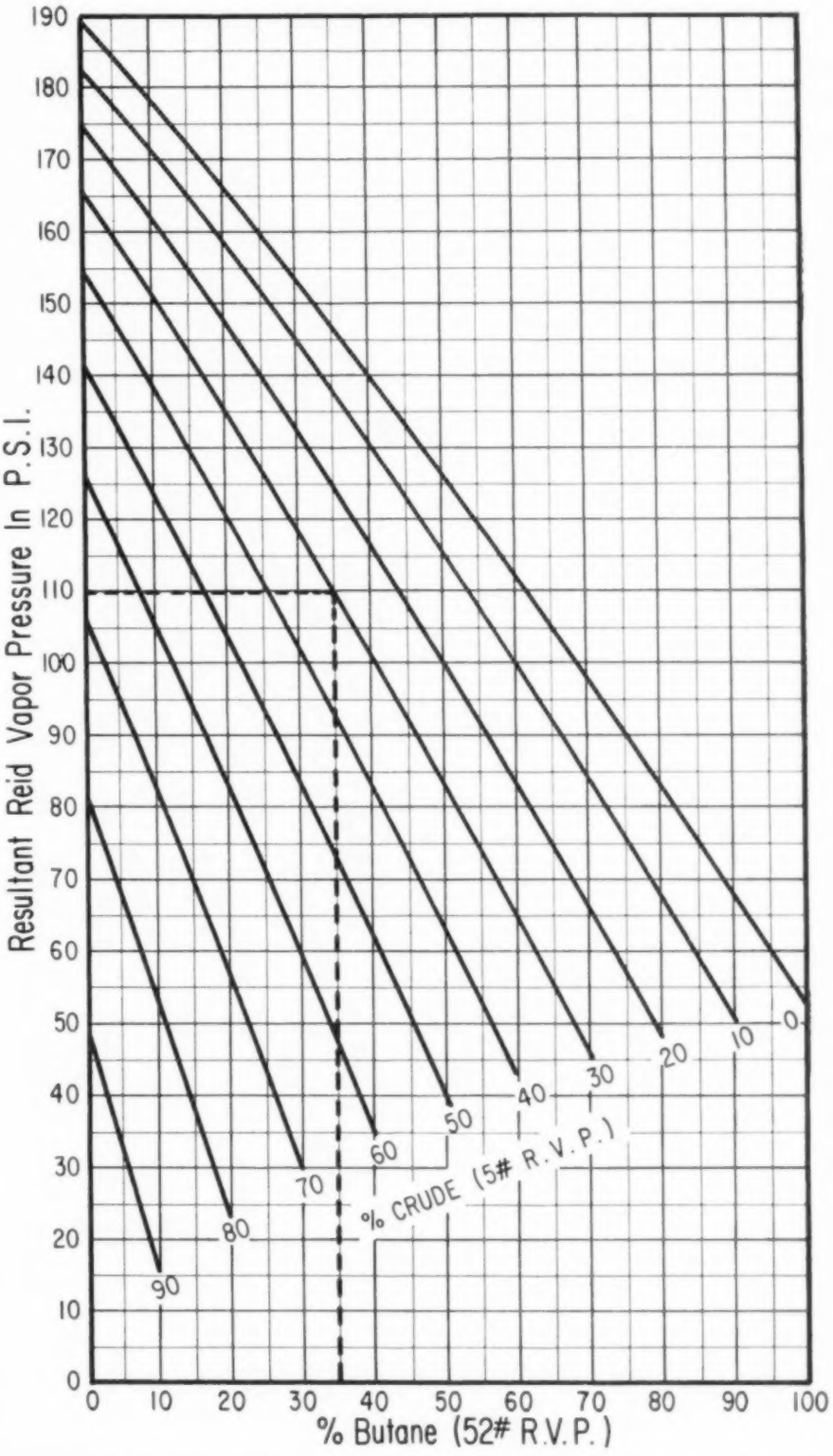


FIGURE 6—Resultant Reid vapor pressure from mixing crude, butane, and propane. A mixture containing 35 percent butane (52#R.V.P.), 30 percent crude (5#R.V.P.), and 35 percent propane (190#R.V.P.) would have a vapor pressure of 109.8 psi. Percent propane equals 100 percent less percent butane and crude.

. . . Where the line has a maximum working pressure, the graph can be used to find different mixing ratios which will give the correct vapor pressure

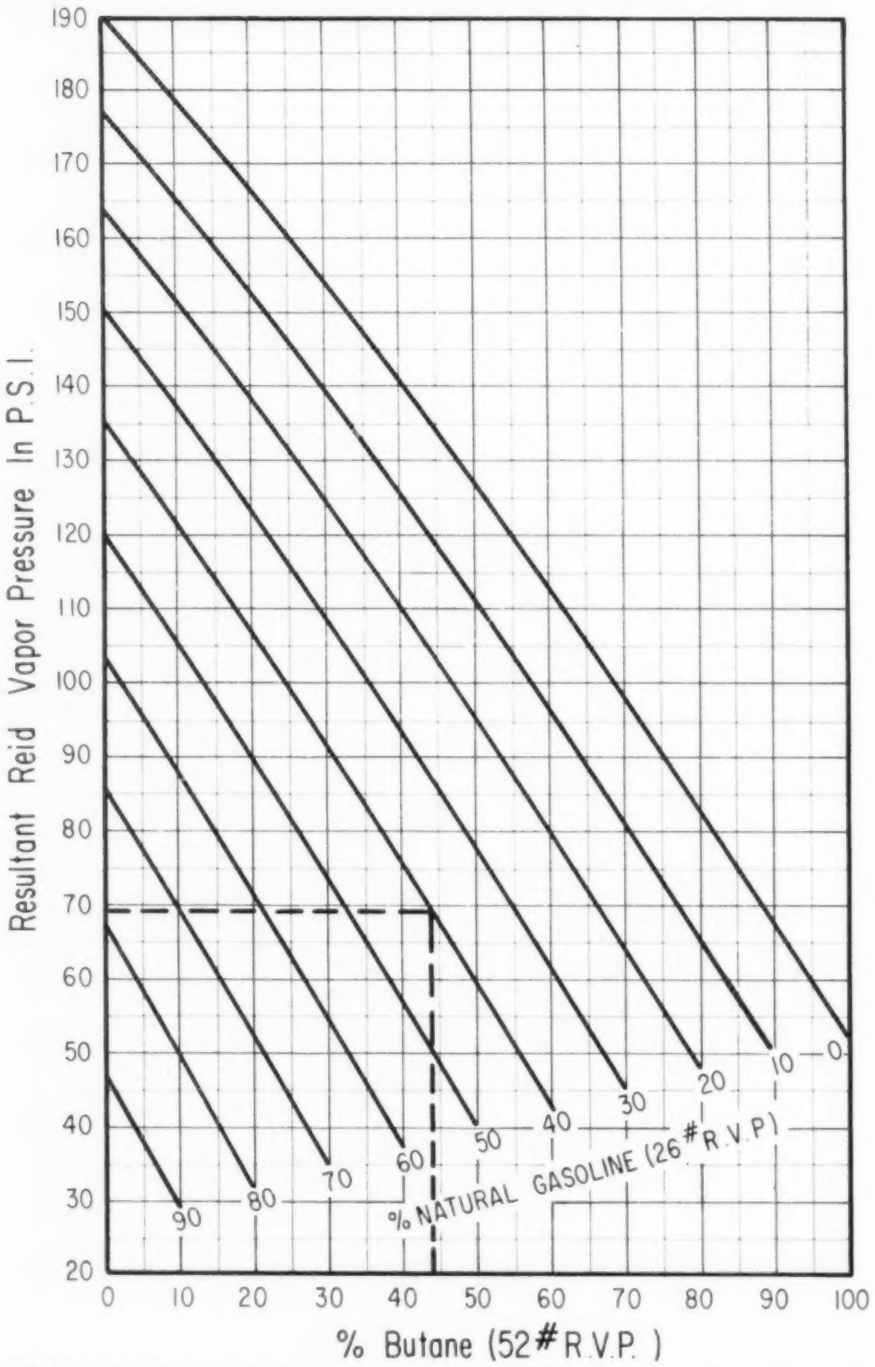


FIGURE 7—Resultant Reid vapor pressure from mixing natural gasoline, butane, and propane. A mixture containing 44 percent butane (52#R.V.P., 40 percent natural gasoline (26#R.V.P.), and 16 percent propane (190#R.V.P.) would have a vapor pressure of 69.4 psi. Percent propane equals 100 percent less percent butane and natural gasoline.

TABLE 2

COMPONENT	Sp. Gr.	Reid Vapor Pressure	Molecular Weight	Mole Constant
CRUDES:				
West Texas Sweet	0.835	6.0	230	0.0302
Golden Trend	0.817	6.8	220	0.0309
Scurry	0.818	8.0	220	0.0310
NATURAL GAS LIQUIDS:				
Propane	0.508'	190.0	44.1	0.0960
iso—Butane	0.563	73.5	58.1	0.0807
n—Butane	0.584	52.0	58.1	0.0837
26# Natl. Gaso	0.628	26.0	73.4	0.0713

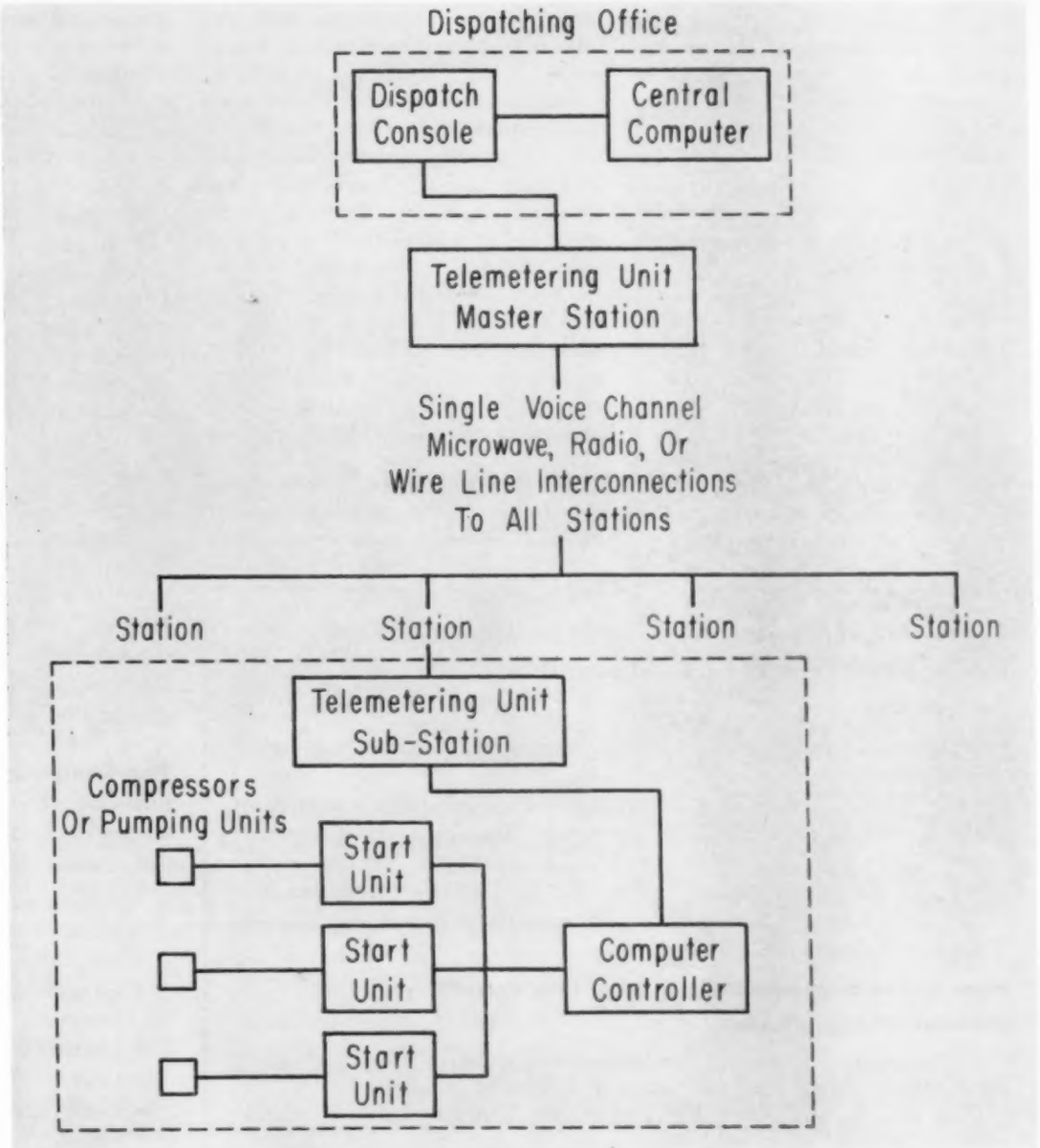
the intersection of this percentage and the curve for the other component.

The remainder of the graphs are for three component mixtures. For each of these there are ten curves, one for each 10 percent (by volume) of one component. This chart is also entered at the bottom with the volume percent of one component. A line is extended vertically upward until the volume percent curve of the second component is intersected. (If the volume percent of the second component is not divisible by ten, it will be necessary to interpolate.) The vapor pressure of the three component mixture is then read opposite the intersection of the curve. The volume percent of the third component is not needed for using the curve. It is equal to 100 percent minus the sum of the percentages of the first two components.

This method has the added advantage of making it easier to work backwards. For instance, some pipe lines have a maximum vapor pressure limit. By reading across the graph at this vapor pressure, a number of different mixing ratios may be read which will give the correct vapor pressure. —**The End**

About the Author

Robert J. Evans has been with Texas Pipe Line Company since graduation from Oklahoma State University in 1948 with a degree in civil engineering. He is a registered professional engineer and has served in design and construction capacities in Kansas, Oklahoma and Illinois. He is now in the Estimating and Evaluating section of the Houston Engineering division.



Schematic diagram of the ultimate control system proposed for control of a pipe line. Telemetering equipment, sequence start units and computer controllers are now in production; dispatching console and central computer for fully automatic control are under development.

Where Do We Stand in Automatic Control?

Remote control of unattended stations is an evolutionary process for most pipe line systems. Present developments have gone about half-way from manual to fully automatic operation.

By Newton E. Armstrong
Southwestern Industrial Electronics Company
Houston

Control of pipe lines has made major strides during the last few years. Several gas transmission companies now have had remote control systems in operation long enough to evaluate their particular pipe line characteristics.

In these systems, data on the performance of individual compressors and controls of the pipe line system are transmitted at frequent intervals to dispatching offices. In response to these data and other available information such as weather and market

demands, dispatchers can calculate necessary adjustments of the operating variables and transmit signals to actuate the various control elements in the system.

With reliable communications systems, this type of pipe line operation has proven to be feasible. Equipment used has been improved through operating experience.

Remote Reset Automatic Control has been developed to achieve still greater efficiency in pipe line control. This method has been based in part on experience gained in remote control. Remote reset automatic control is an improvement over remote control in three ways: it provides greater reliability of control, decreased workload for the dispatching staff and economy in communications equipment.

Fundamentally, remote reset automatic control differs from remote control by placing the decision-making and computing portions of the control system in close proximity to the equipment being controlled. This computing equipment is then caused to direct performance of the mechanical equipment for continuous production of some prescheduled function. Computing equipment affects the utilization of the remote reset features for subsequent changes in the basic schedule.

Basic Design Points. The compressor station is the major mechanical assembly to be considered in designing control equipment for remote reset automatic control of gas pipe lines. A study of pipe line company needs indicates that with current dispatching practices the compressor station should be treated as a device for the development of a desired discharge pressure.

Control equipment should therefore be designed to reproduce continuously any desired discharge pressure which the physical equipment of the compressor station is capable of producing, while maintaining optimum efficiency at all times.

Computing equipment applied to a given compressor station has to be capable of coordinating the functions of several compressors and a number of auxiliary devices as a single purpose unit. This computing equipment furthermore has to be designed to be capable of receiving, storing and acting upon signals directing changes in desired discharge pressure.

The Computer and Control. The following variables affect compressor station discharge pressure:

1. Station suction temperature
2. Station suction pressure
3. Number of operating compressors (on-line)
4. Compression ratio of each compressor
5. Elevation and barometric pressure
6. Composition of gas moved
7. Over-all dynamic behavior of compressors and station piping
8. Speed of engines

Some of these features vary rapidly, others slowly, and still others remain constant for a given installation. Computing equipment must be capable of receiving settings for those features which are constant and receiving information on the latest values of the variables. In addition, the computing equipment must be capable of maintaining a desired discharge pressure in the face of constantly shifting variables by causing start and stop of compressors, speed change in compressors, and variation in compression ratios.

Thus the array of computing equipment must be provided with a number of data input channels and a number of control signal output cha-

Evolution of Automation for Pipe Line Systems

Human observation and manual control

Semi-automatic

- Sequence controllers receive station starting information then select each step in proper order.
- Signals indicate trouble: Minor equipment casualty; Equipment casualty necessitating shutdown but not repair; Equipment casualty—shutdown and repair; Station disaster.
- Control system provides manual control of flow rate and continuous comparison of actual flow rate with prescribed setting, adjustments are made automatically.

Now under development for pipe line systems . . .

Remote setting automatic

Telemetering unit reads information stored in controller upon demand, converts it to coded data, and sends it to desired locations.

Data may be sent to maintenance station only for relay; or trouble information may go to maintenance station, flow rate and maximum flow rate to the central dispatching office.

Telemetering equipment at receiving point transmits signals to all stations connected, selects flow rates, and receives and displays the four equipment failure trouble signals.

As data is received, automatic interrogation of the stations is made in sequence . . . answers are automatically printed out.

All local measurement points in stations are automatic with remote reset provided.

Trouble signals are relayed to maintenance men at remote locations.

Information needed for general system control is telemetered automatically to a general dispatching office.

Means for remote reset of all controls are available from the central office.

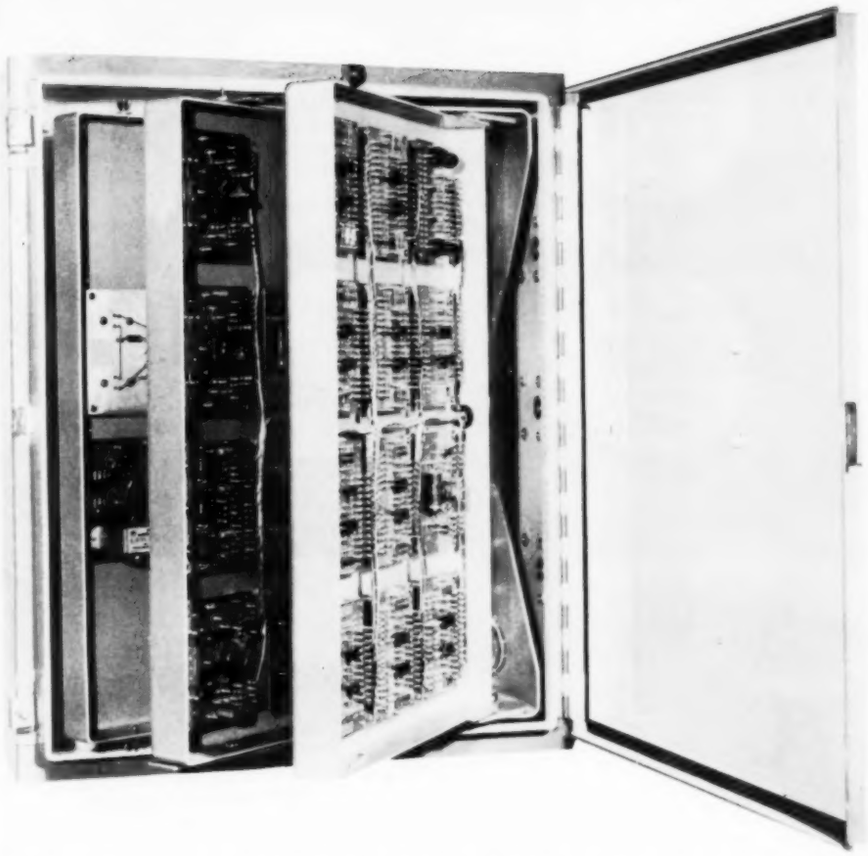
- ***Full Automatic . . . the ultimate goal in automatic control . . .***

Pipe line computer is connected directly to all of the telemetering terminals at the central dispatching control center.

Computer completely controls the system.

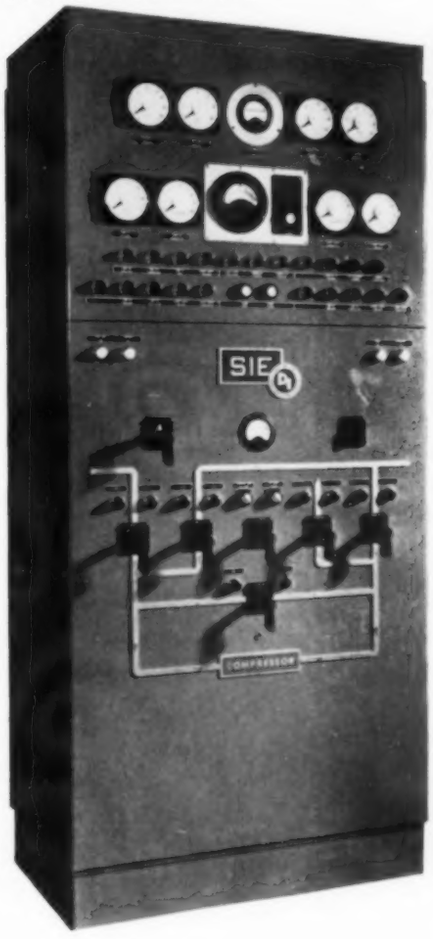
Information such as weather data, market demands, contract changes are manually introduced.

With automatic program and this variable data the computer provides continuous and instantaneous control solving operational and flow equations to get the most practical, efficient, safe and economical transmission of gas over the entire system.



A typical compressor start panel, that is the initial unit of a remote reset automatic gas pipe line system. It consists of two sections; the sequencing unit proper and a monitoring display unit. The sequencing unit causes a compressor to go through the orderly steps for starting and stopping. It also provides a proper stop sequence to be followed when station troubles occur and receives and displays signals that indicate a variety of alarm conditions.

Telemetering transceiver provides for transmission and reception of coded measurements and commands.



nels. Basic control equipment must be designed for control of many different compressor stations with different numbers and types of compressors. For economy in design it is necessary that essentially universal types of computers be produced.

The most feasible method of providing standard designs for widely varying situations was to divide the entire computing and controlling system into several separately installable packages. Ignoring for the moment the remote reset features, it has been found that the best solution involves the use of two types of packages: (1) a compressor start unit and (2) a compressor station computer controller. In order for a compressor station computer controller to operate efficiently it must be capable of starting and bringing on the line a given compressor through the use of only one actuating signal. It is for this reason that the compressor start unit was primarily developed.

Compressor Start Unit Functions. The compressor start unit has certain additional functions. The first is that it permits, by itself, highly efficient semi-automatic operation of a compressor station from a station control room. Second, it provides a terminal point for the introduction of a certain information signal to the compressor station computer controller.

An easy step-wise approach to complete remote reset automatic control can be followed by a pipe line through initial installation of compressor start units, later addition of compressor station computer controllers, still later addition of telemetering equipment for remote reset, and final installation of a central computer for automatic dispatching. —**The End**

About the Author

Newton E. Armstrong, product manager, special products, Southwestern Industrial Electronics Company, has been active in the design and engineering of automatic control systems for several years. His background includes design of information storage systems at Battelle Memorial Institute and research manufacturing operations at IBM. Armstrong has developed a basic design for a multistage programable machine tool and a digital machine tool control system, as well as system designs for process control. He is a graduate in biophysics from Ohio State University and served in the U. S. Army as a communications officer. His postgraduate studies include work in biochemistry, logic, statistics, radio theory, telephone and switchboard design, communications system layout, electronic circuit theory and design, digital logic, magnetic theory, semi-conductor design, and digital computer design and programing.

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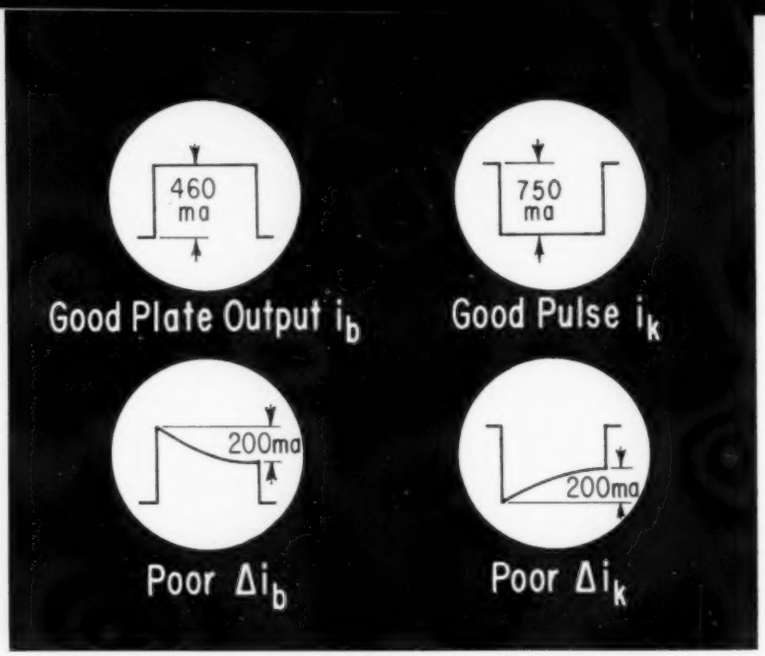

FIGURE 1—Input pulse and typical output pulses of good and poor tubes as viewed on an oscilloscope. The pulse leading edge may indicate desirable current values. A severe drop during the pulse is indicative of poor cathode emission.

Tester Can Cut Microwave Tube Costs

Portable field tester uses current division method to check 2C39 tubes. Weak tubes can be located quickly, reducing maintenance costs and the danger of microwave failure.

RELIABILITY OF microwave operation can be increased and tube replacement costs decreased with a quick accurate test to locate weak tubes. Using the current division method, tubes that have too large a rating for conventional tube checkers can be analyzed. Without a method of testing the tubes, maintenance personnel working under pressure may change tubes without regard to their quality in order to restore the circuit promptly.

With experience the field service man can predict tube failure and determine whether a tube will operate satisfactorily until his next scheduled service call, eliminating many unnecessary system failures. Also, a tube that is too weak for one location may still be satisfactory in circuits with a lower power rating. Tubes with intermittent short circuits, open circuits, gas and arcing may be detected—as well as those with poor output due to misalignment or electrode spacing and low cathode emission.

Tester Has Many Applications. Probably the most costly of the normally consumable items in systems operating in frequency bands below, 3,000 Mc, is the 100-watt 2039-series planar triode vacuum tube. Microwave transmitters may have as many as four of these relatively expensive tubes in each transmitter.

In addition to testing tubes which are in use, testing new tubes before they are placed in the users' stock will locate tubes which have been damaged in transit, or are otherwise defective, and result in aditional savings.

With the increasing occupancy of the 450-470 Mc. band by mobile service users, and the increasing probability of the use of other frequencies up to, or beyond, 1,000 Mc. for mobile service, the use of the type 2039-series tube is by no means limited to fixed service operations.

Meter Based on Quality Control Test. Current division is a test developed by one of the tube manufacturers and used by them for several years in controlling tube quality. It has been incorporated into military procurement specifications for type 4X150, and has been recommended for adoption for military equivalents of 2039's. The X558A (now called 3CX100A5), has been production-controlled by current division for some time. Development of a small portable instrument has made this test available for on-the-spot tube checking.

Square Wave Pulse Used. Current division places a long square wave pulse of 4,500 μ sec. on the tube grid which is adjusted in amplitude (voltage) until a standardized pulsed

plate current is attained (460 ma). Values of grid pulse voltage and current are noted. They define the positive grid operating condition of the tube. As grid voltage or current increases beyond initial values the tube is shown to be deteriorating.

By viewing the output pulses on an associated cathode ray oscilloscope, the electron emission qualities of the tube under test become known. Figure 1 shows sketches of input pulse, and typical output pulses of good and poor tubes.

The pulse leading edge may indicate desirable current values. A severe droop during the pulse is indicative of poor cathode emission.

Failures Predicted. When using the tests to predict an imminent tube

FIGURE 2—Portable tester developed to allow use of the current division test at remote locations. Developed as a quality control test in the manufacture of the 2C39 tube, this test will provide a quick and accurate check of the tube.

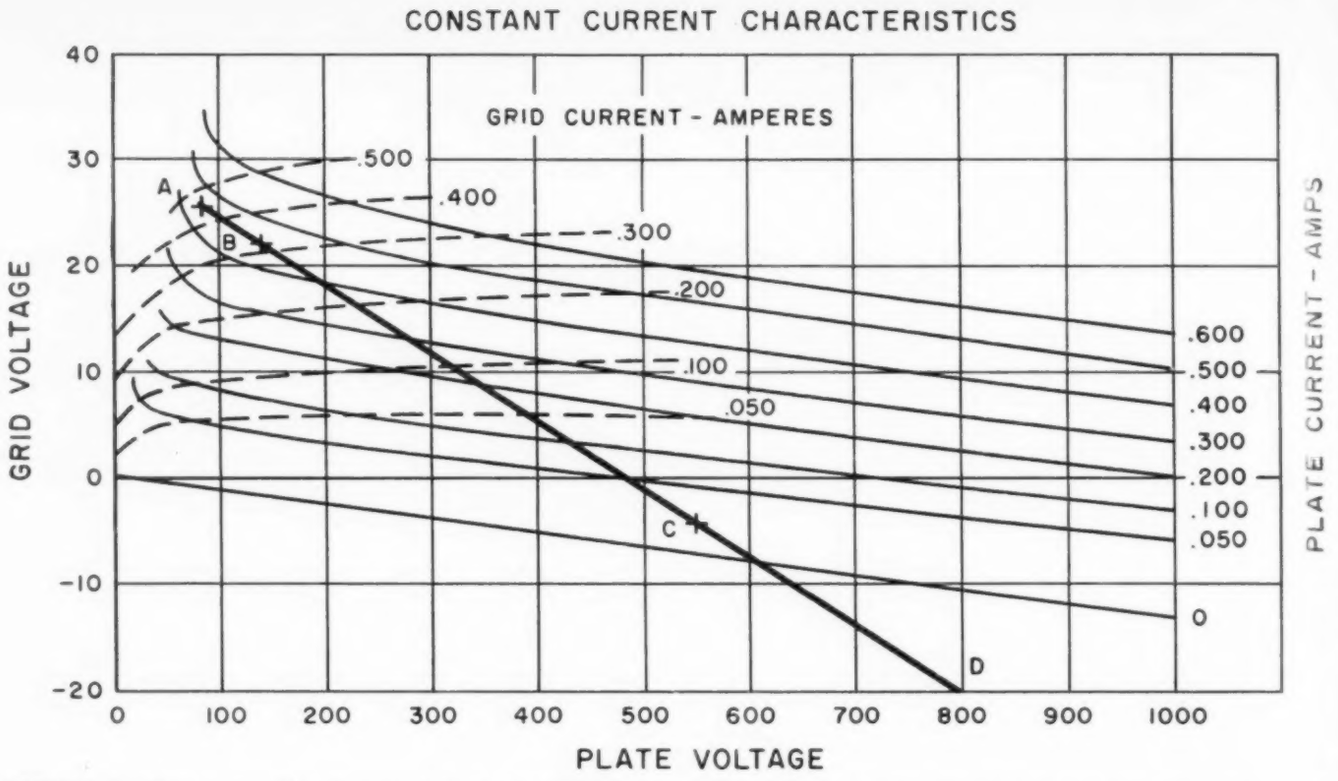

FIGURE 3—Class C operating characteristic of the 2C39 tube. The tube characteristic at point A or B is most significant in class C operation. By measuring the grid current required to reach point B, the current division test provides a measure of drive power efficiency.

failure due to loss of emission, heater voltage is reduced by ½ or even 1 volt. The degree of change for current, voltage, or pulse droop can be a fair indication that actual operational failure is approaching.

Cathode Emission Also Tested. The test set also incorporates the pulse emission test, which has long been a part of the military acceptance specification for 2C39 and similar tubes. This uses the same input pulse as current division, but total cathode current is adjusted to 750 ma when the heater is reduced to 5 volts. A pulse droop of less than 100 ma between the pulse leading and trailing edges is acceptable for a new tube. When this droop increases significantly, the cathode emission capabilities may be considered inadequate for pulsed transmitter service.

Accurate Square Wave Pulses Provided. The test set incorporates power supplies capable of providing accurate square wave pulses under loads up to 1 ampere. It employs a pulse timing circuit adjusted for a pulse repetition rate of 11± 1 pps. This in turn triggers a mercury-wetted relay to create square wave pulses of 4,500 μ sec. length, and having rates of rise and fall of much less than 5 μ sec.

A specially designed socket holds the 2C39 tube under test. In addition, an octal socket is provided so that other tube types, such as 2C40 or 2C43, may be subjected to current division when their test parameters have become established. Accurate low ohmic value resistors permit the output pulses to be viewed on an associated scope.

The sync pulse is of sufficient amplitude so that even low power gain scopes may be employed for rough field evaluation work. Finally, a calibrating circuit is provided, so that

About the Authors

Briggs

Sharpe

Thomas H. Briggs, president Briggs Associates, Inc., has had 30 years in tube manufacturing and development of tube materials. He has had wide experience in computer components and manufacture, specializing in new product development of automatic equipment and data handling systems. He holds a B.S. degree in physics from Wesleyan and an M.S. from The California Institute of Technology.

M. O. Sharpe superintendent of communications for Trunkline Gas Company, has had wide experience in the communications field. As an electronics engineer he has been associated with a number of radio stations throughout the country.

He is a graduate of the University of Tennessee and the Capitol Radio Engineering Institute in Washington, D. C., and served with the FCC as principal radio engineer from 1941 to 1950.

Sharpe is a commander in the USNR having served during World War II as an electronics engineer. He is a senior member of IRE, and a member of the National Geographic Society.

scope amplitudes of 500 ma may be known with accuracy, thus permitting easy change of scopes, or use of those without self-contained calibrating means.

Discarded Tubes Found Operable. Several hundred 2C39 tubes which had been removed from a chain of microwave relay transmitters were tested during development of the tester. Of these, an appreciable percentage were classified as operable. Thus, it is quite likely this lot of tubes could have provided many more life hours than previously suspected.

Conversely, tube procurement savings of significant dollar value were indicated. Savings found in this lot of tubes alone repaid the cost the test set. Further, by placing certain grades of worn tubes from higher frequency sockets into sockets operating at lower frequencies even more life hours can be expected.

Characteristic Curves Prove Value. Justification of the current division test is illustrated in Figure 3. This shows a representative Class C operating characteristic (A-D) superimposed on the constant current static characteristic of a typical 2C39 tube. Conventional tube tests provide a dynamic transconductance measurement representing the negative grid characteristics typical of a point in the vicinity of C on the figure. Actually the tube characteristic at point *A* or *B* is most significant in Class *C* operation. Point *B* has been chosen as being nearest the center of design range for 2C39 tubes. It is specified as 145 plate volts and 0.460 plate amperes.

Different tubes will require more or less grid voltage and current to reach this point. In a given design, supply voltage and load resistance are fixed, and drive voltage and current are limited; i.e., different tubes will provide more or less plate current swing and therefore give more or less power output.

Other Properties Checked. By measuring the grid current required to reach Point B, the current division test provides a measure of drive-power efficiency.

Correlations have been shown between droop in the plate current pulse (i_b) and pulse emmission ($\triangle i_k$). Thus, for field service work the current division test alone may be used, permitting the shortest possible time for determining tube operation capabilities. Excellent correlations also exist between *CD* and transconductance (G_m). These are so good that G_m testing may be omitted safely.

Figures 4 and 5 indicate the effect of current division values as heater voltage and pulsed plate current settings are varied over a wide range. These demonstrate that reasonable i_b variations are tolerable without voiding effectiveness of the test, and that reductions in heater voltage can be employed for marginal testing.

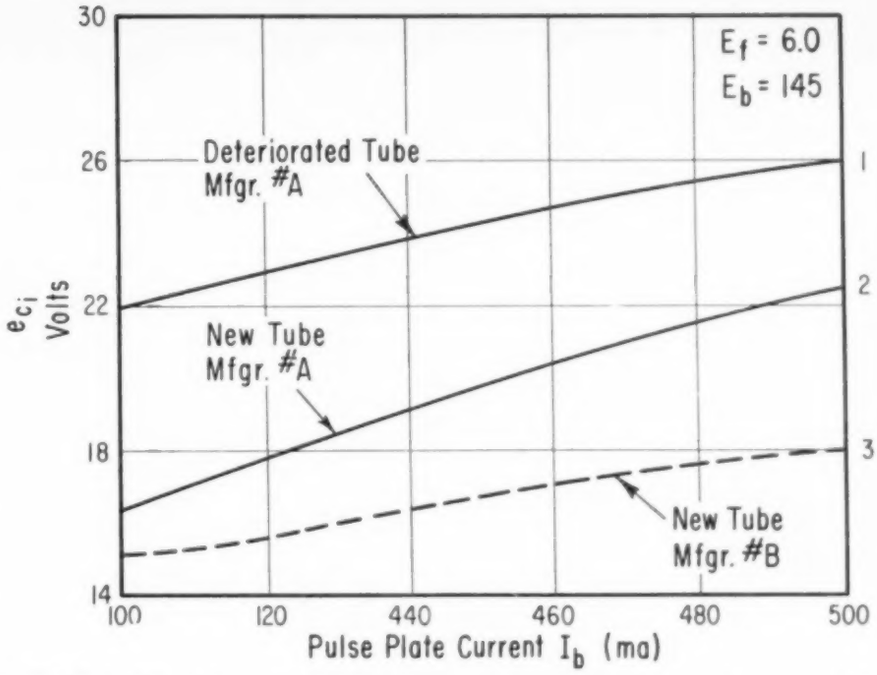

FIGURE 4—Effect of current division values as pulsed plate current settings are varied. Reasonable i_b variations are tolerable without voiding effectiveness of the test.

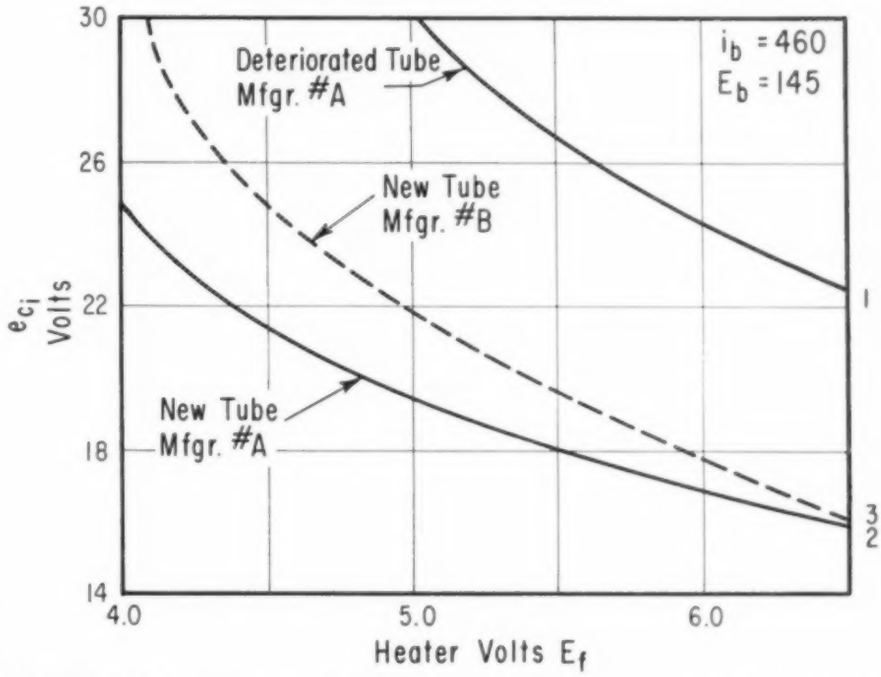

FIGURE 5—Effect of current division values as heater voltage is varied. Reductions in heater voltage can be employed for marginal testing.

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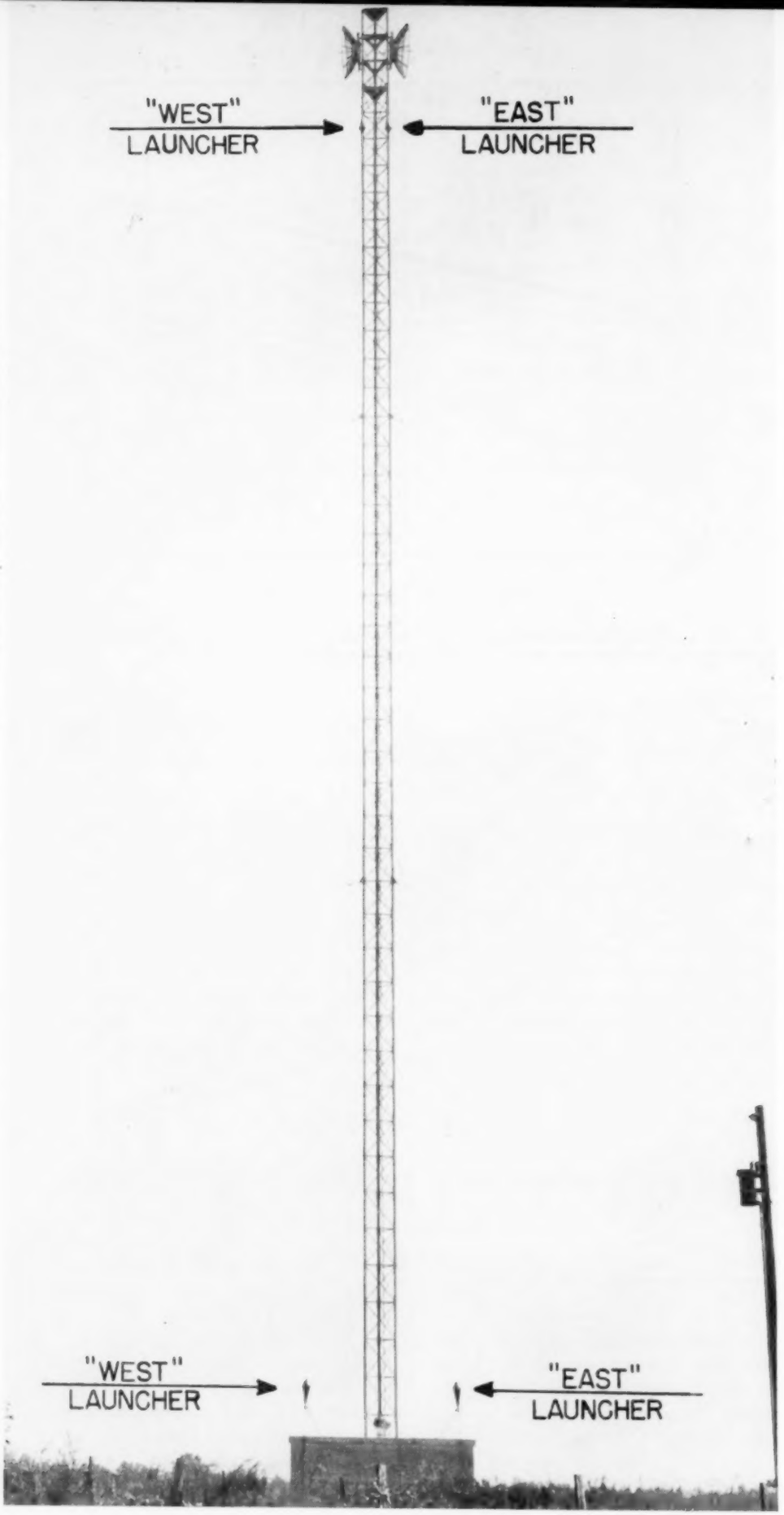


Typical installation of surface wave transmission line on a pipe line microwave tower consists of two single insulated conductors and four "launchers." Operating signal loss is approximately 0.835 decibels for 100 feet of line.

Single Line

Two "launchers" and an insulated line that transmits signals from ground equipment to antennas reduce installation costs. Tests indicate that these lines would be especially good for emergency replacements.

AN INTERESTING new microwave development now under test by several of the larger gas pipe line companies promises to cut the cost of antenna systems. This transmission line, which is actually nothing more than a length of wire with an insulation coating connecting two launchers, serves to carry radio frequency signals from antennas mounted on the towers to equipment on the ground.

It is being tested as a substitute for the more costly coaxial cable previously required. Two years of operating tests have proven successful, in spite of some of the fears of icing problems. These lines are considered ideal by several companies for fast, low-cost emergency antenna tower lines.

Tests have been made without the use of de-icing or heating equipment; it is believed that except for very severe winter conditions, such devices are not required in pipe line communication service.

Installations are simple, consisting of a "launcher" at the top of the tower connected to the microwave antenna and another at the base of the antenna tower connected to the radio equipment. Flexible connections from the "launcher" to the antenna and from the other "launcher" to the equipment are made with RG-1/U type cable.

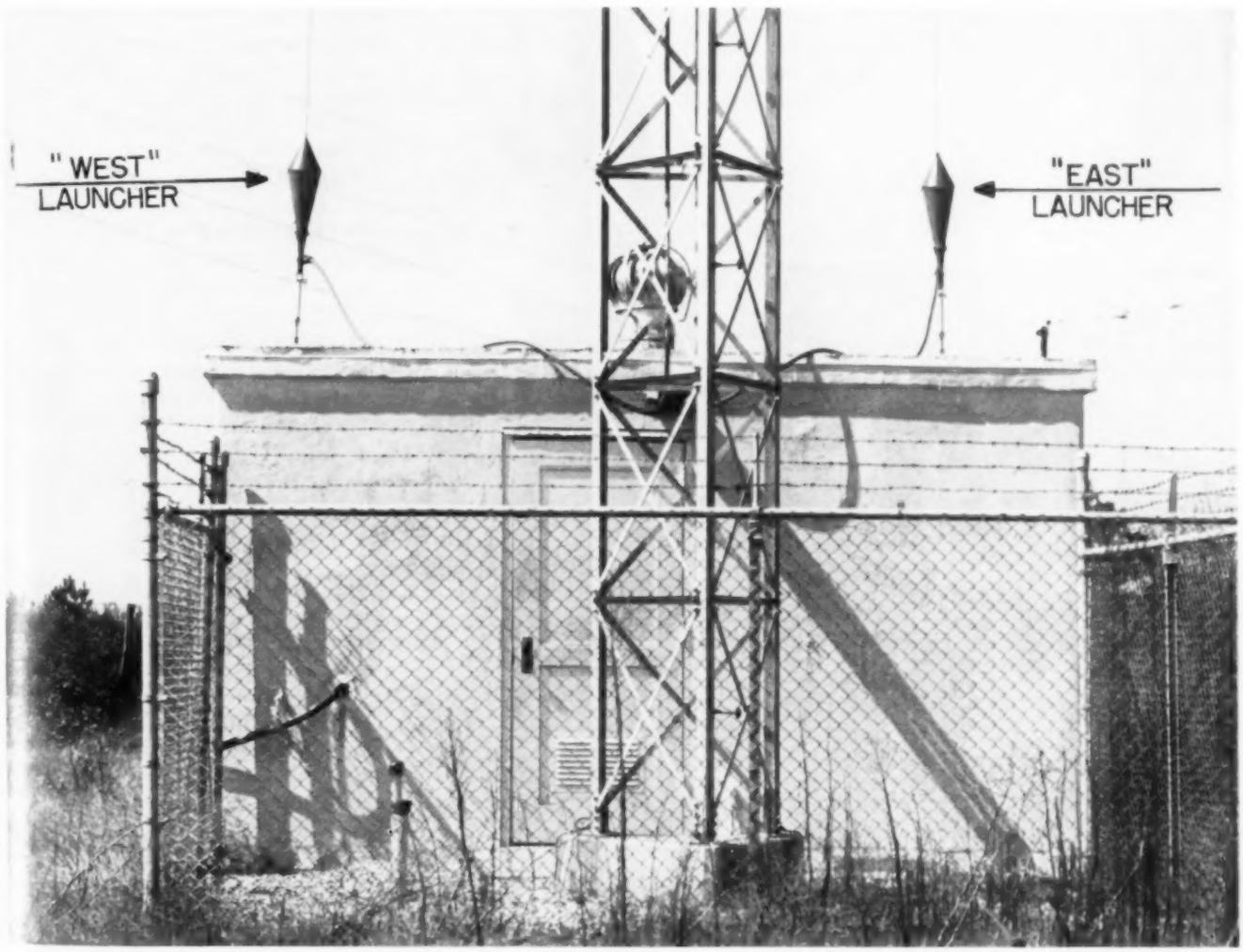
Substitutes For Co-Ax on Microwave Towers

How They Work. These flexible transmission lines are an outgrowth of years of research studying and developing the surface wave concept of electromagnetic propogation. Background of the surface wave concept is of interest although somewhat complicated.

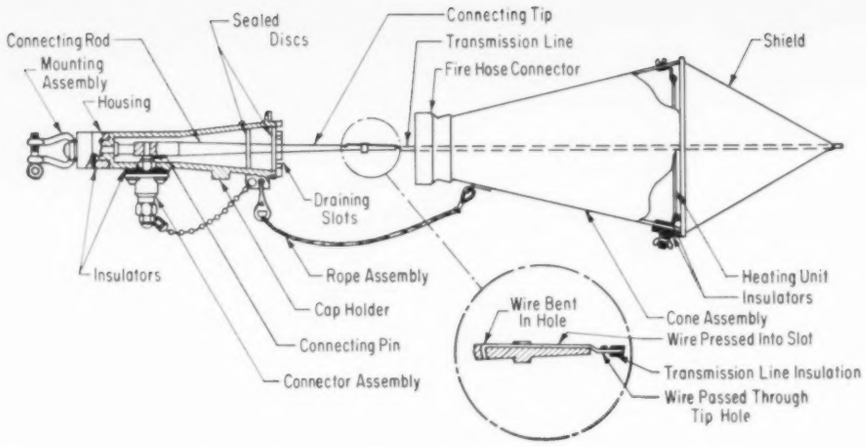
Around 1900 physicists began searching for explanations to several problems in electromagnetic radiation including the behavior of an electric field or wave at the boundary of two different materials such as air and earth. One mathematician named Summerfeld predicted the existence of a surface wave which was guided along the juncture of any adjoining substances of different natures. In later years several scientists argued this, pro and con.

Recent research by Dr. George Goubau led to the evidence that an insulating dielectric coating on a low loss copper wire did indeed cause this surface wave to travel from one end of the wire to the other. This technique was patented; extensive work was done for the military on this subject before it became available for commercial use.

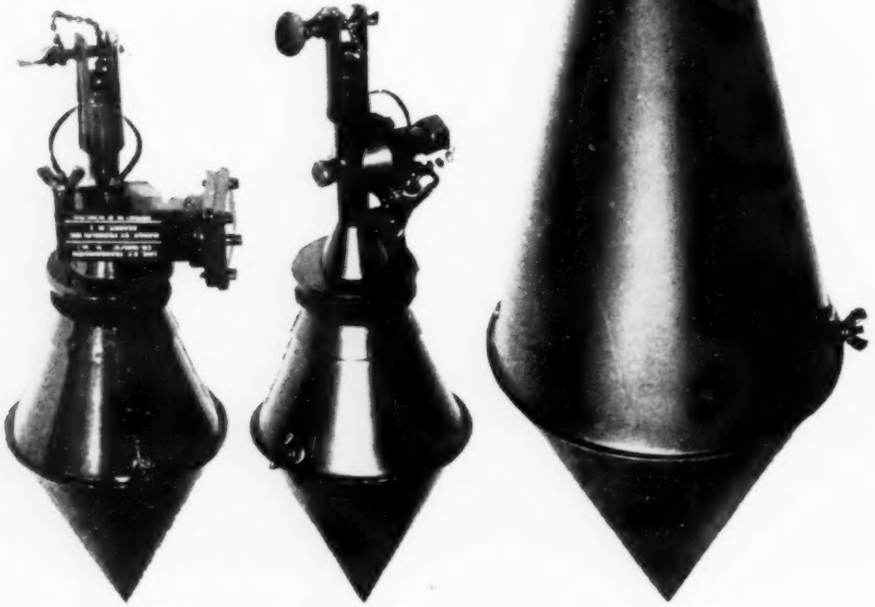
Conical Launchers. This research showed that by putting a special cone at each end of a wire, radio waves could be launched from a conven-



Launchers are connected to ground microwave equipment by means of short lengths of coaxial cable. In two year tests by gas pipe line companies, no de-icing equipment was provided except under the most severe conditions. Summer fade allowances were considered sufficient to handle icing losses during brief melting periods.



Cut-a-way view of the conical launching unit for the surface wave transmission line. One unit "focuses" the signal from a coaxial cable into single line conductor; another at the top of the tower feeds the signal to the antenna. Operating loss in each launcher is about 0.5 decibels.



7100-8500 MEGACYCLES

4400-5000 MEGACYCLES

1700-2400 MEGACYCLES

Launching units for the surface wave transmission lines are designed for three megacycle bands. Of special interest to gas pipe line communications engineers is the 1700-2400 megacycle unit for microwave systems.

tional two conductor coaxial cable into the simple inexpensive single conductor, taken to the place needed and picked up with a saving in initial cost and maintenance compared to other types of energy transmission.

Available for Microwave Bands. Lines based on this principle are now commercially available in the 1,700 to 2,700, 4,400 to 5,000 and 7,100 to 8,500 megacycle bands. The 1,700 to 2,400 megacycle band is of special interest to pipe line communications engineers as these frequencies are used by microwave systems in this service.

For this band the voltage standing wave ratio is 1.5 to 1 maximum over the band, power handling capabilities equal to that of 7/8-inch air dielectric line or 1.32 KW maximum average. Operating loss is approximately 0.835 decibels per 100 feet of line plus 0.5 decibels for each of the two launchers or field transformers.

For a 300-foot run, the line would have about 3.5 db loss, compared to 6.0 for semi-flexible transmission line.

Input and output impedance is 50 ohm, the coaxial line connectors are 7/8-inch RETMA flange, and the transmission line length is 500 feet maximum.

Cost Comparisons. The use of these lines on shorter runs will not bring out much of a saving. However, installation prices are estimated to be in the vicinity of:

	Line and Launchers		Flexible Co-ax Cable
150 feet	$488	(7/8")	$ 650
260 feet	494	(1 5/8")	1,400
310 feet	496	(1 5/8")	1,550
410 feet	500	(1 5/8")	1,850

De-icing equipment is available for extreme operating conditions, but because of the fact that trouble from icing usually occurs only during a melting period span of approximately 30 minutes the probable decibel loss of 5 or less was not thought to be a matter of serious concern. Normal built-in fade margin for summer fades should adequately take care of such a small loss.There should be no heavy fades during this icing weather.

Communication engineers predict that this new development in tower transmission lines will find an important place in future industrial microwave systems. —**The End**

How Much Mixing Occurs Between Batches?

Use of these graphs will help you predict contamination fraction at stream interface for downstream stations.

By **Octave Levenspiel**
Bucknell University
Lewisburg, Penn.

ALTHOUGH there is a wealth of experience with batching of pipe line shipments, there is real need for a better understanding of the relationships bewteen fluid flow theory and actual field results. When two different fluids are batched through a cross country pipe line a zone of contamination forms in the interface region. Effect of mixing in the line is shown in Figure 1.

With charts presented in this report, the zone of contamination is related to a dispersion number and the pipe dimensions. The dispersion number in turn is obtained from a correlation with Reynolds numbers.

The over-all design aspects are not considered here. Refer to Birge[1] for these.

Turbulent flow gives the correlation of dispersion numbers with Reynolds numbers as shown in Figure 2. For Reynolds numbers above 10,000 the theoretical curve is shown and it brings together much data from the laboratory and the field for both gases and liquids. Pipe sizes varied from 0.02 to 40 inches in diameter and lengths as great as 400 miles were used. As the Reynolds number is progressively decreased below 10,000, however, the one experimental study in this range to date shows an increasing deviation from the theoretical curve. This may be expected for in the development of the theory the laminar sublayer is ignored and it is precisely in this region (Re < 10,000) that the sublayer becomes appreciable in thickness. This may result in the additional contribution of molecular diffusion in the sublayer as a means of axial transport.

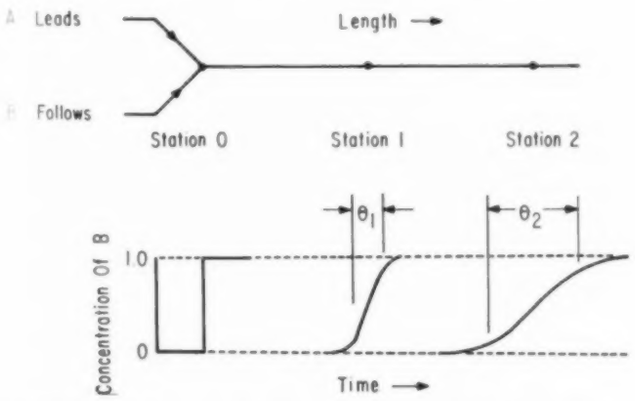


FIGURE 1—When one product (A) is followed by another (B) there is a zone of mixing. The time (θ_i) for this zone to pass a point is proportional to the contamination width.

Streamline flow is of little interest in product pipe line design. In this region of flow the zone of contamination is much greater than with turbulent flow. However, the correlation of dispersion number for streamline flow is shown in Figure 3. Here molecular diffusion plays a significant role in product contamination.

For short pipe the diffusion mechanism is not applicable. Figure 3 should be used only when the following condition is fulfilled:

$$(\mathrm{Re})\ (\mathrm{Sc}) << 30\,\frac{L}{d}$$

The few data available check these theoretical predictions.

The contaminated zone as related to the system variables is shown in Figure 4. The method used for preparing this figure is described in the accompanying box. The following problems illustrate the various uses of these charts.

ILLUSTRATIVE PROBLEMS

In these problems *A* refers to the leading fluid and *B* refers to the following fluid in a 12-inch ID pipe. Stations 1 and 2 are 100,000 and 1,000,000 feet downstream from Station 0, the point of feed origin as shown in Figure 1.

Problem 1—If at Station 1 the 10%-90% contaminated width is 500 feet find the 1%-99% contamination width and the 10%-99% contaminated width at that station (10%-99% contamination means allowing up to 10% of *B* in *A* but only allowing 1% of *A* in *B*).

Solution—The fraction contaminated

$$F_{20\text{-}90} = 500/100{,}000 = 5 \times 10^{-2}$$

From Figure 4 this corresponds to

$$D/uL = 1.9 \times 10^{-5}$$

Using this value of D/uL we find from Figure 4 that for a 1%-99% contamination

$$F_{1\text{-}99} = 9.2 \times 10^{-3}$$

therefore the contamination width

$$W_{1\text{-}99} = (9.2 \times 10^{-3})\ (10^5) = 920\ \text{ft.}$$

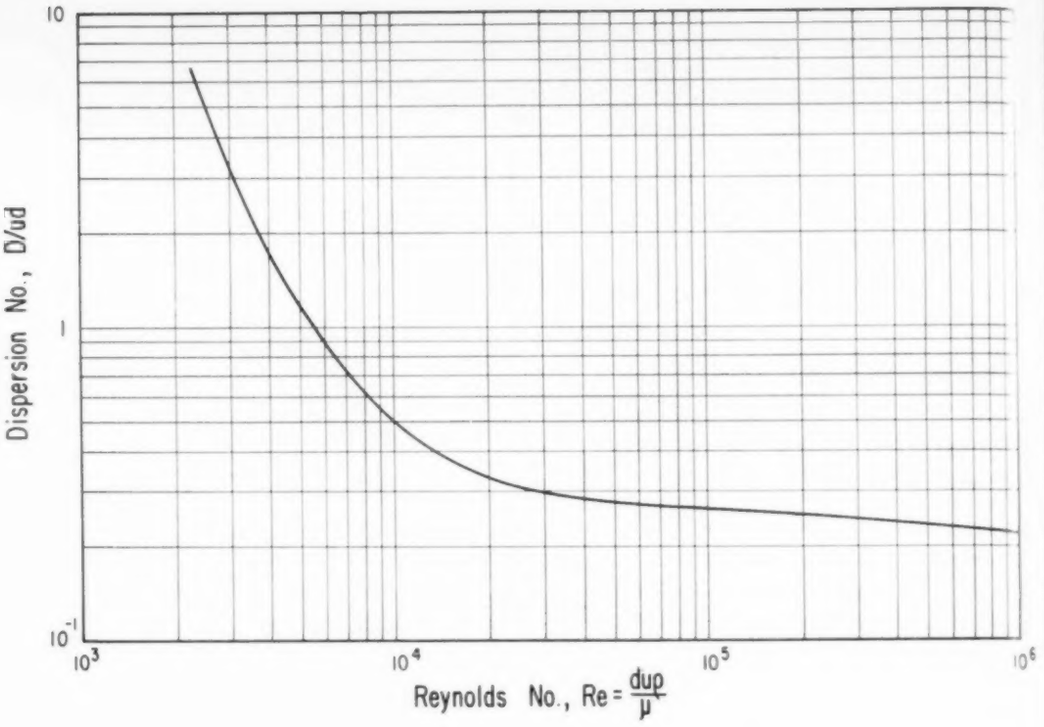


FIGURE 2—For Reynolds numbers above ten thousand the dispersion number is a function of the Reynolds number. Here is the relation for this turbulent region of flow.

To find the 10%-99% contaminated width we proceed as follows:

$$W_{10-99} = W_{10-90} + W_{90-99}$$

But as the S-shaped contamination curve is symmetrical in this region $(D/uL < 0.01)$

$$W_{10-50} = \frac{W_{10-90}}{2}$$

and

$$W_{50-99} = \frac{W_{1-99}}{2}$$

therefore

$$W_{10-99} = \frac{1}{2}(W_{10-90} + W_{1-99})$$

$$= \frac{1}{2}(500 + 920) = \mathbf{710\ ft.}$$

Problem 2—If at Station 1 the 10%-90% contaminated width is 500 feet find the 10%-90% contaminated width at Station 2.

Solution—The fraction of pipe line which is 10%-90% contaminated at Station 1 is

$$F_{10-90} = 500/10{,}000 = 5 \times 10^{-2}$$

From Figure 4 at Station 1

$$(D/uL)_1 = 1.9 \times 10^{-4}$$

For constant flow conditions D and u remain unchanged, therefore for Station 2

$$(D/uL)_2 = (D/uL)_1(L_1/L_2) = 1.9 \times 10^{-4}(10^4/10^5) = 1.9 \times 10^{-5}$$

And again from Figure 4 but for Station 2, the fraction of pipe line contaminated

$$(F_{10-90})_2 = 1.6 \times 10^{-2}$$

Hence, the 10%-90% contaminated width at Station 2

$$(W_{10-90})_2 = (F_{10-90})_2 \cdot L_2 = (1.6 \times 10^{-2})\ 10^5 = \mathbf{1600\ ft.}$$

Note—In general for small D/uL $(D/uL < 0.01)$ the contaminated width varies as the 0.5 power of the pipe length as may be seen by the slopes in Figure 4. For example, if the length of the pipe line were increased 16 times the contaminated width would increase by a factor of 4.

Problem 3—If at Station 1 the contaminated width is 500 feet for flow in a 12-inch ID pipe what would it be in a 3-inch ID pipe for the same Reynolds number?

Solution—The Reynolds number is constant hence D/ud is unchanged. But

$$(D/uL) = (D/ud) \cdot (d/L)$$

Hence

$$(D/uL)_{3''\,pipe} = \frac{1}{4}(D/uL)_{12''\,pipe}$$

And from Figure 4

$$F_{3''\,pipe} = \frac{1}{2}F_{12''\,pipe}$$

Therefore the contaminated width for the 3-inch pipe,

$$W = \mathbf{250\ ft.}$$

Problem 4—If at Station 2 the average Reynolds number of the two fluids is 10,000, find the 10%-90% contaminated width.

Solution—

From Figure 2

$$(D/ud) = 0.4$$

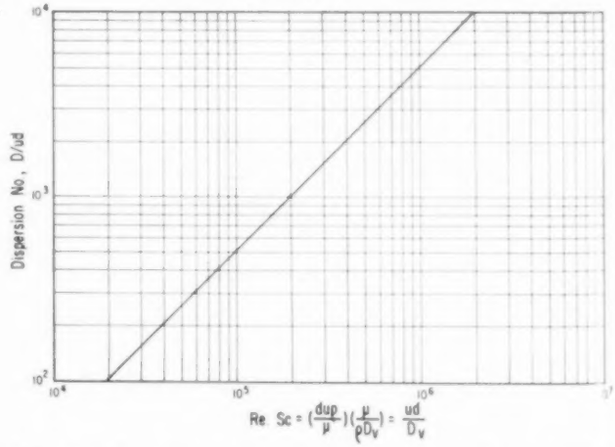


FIGURE 3—Here is the chart for getting the dispersion number for streamline flow. It is only applicable when (RE) (Sc) $<< 30\ \frac{L}{d}$.

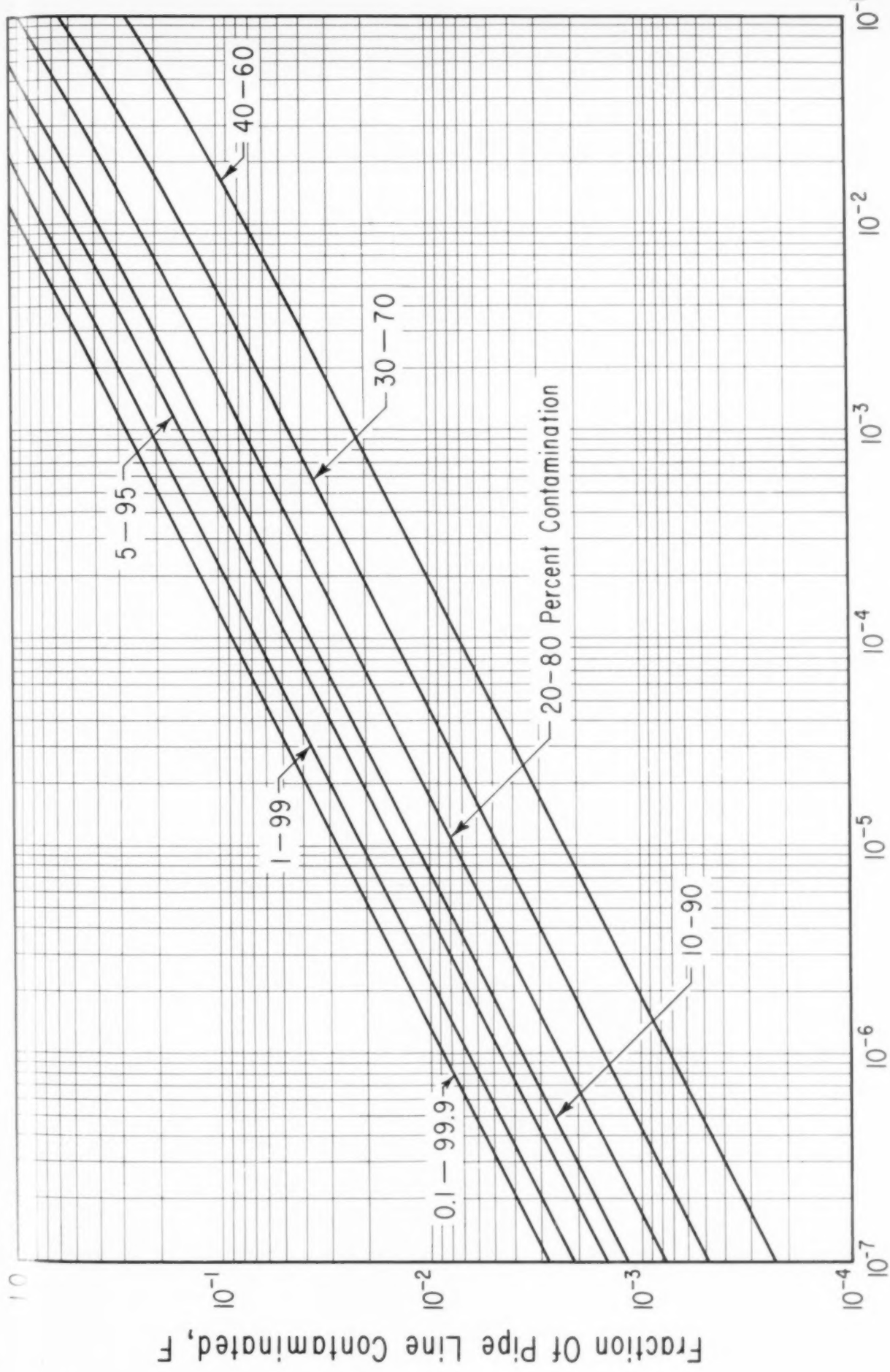


FIGURE 4—The example problems bear out that streamline flow results in much greater contamination than turbulent flow.

Therefore

$$(D/uL) = (D/ud) \cdot (d/L) = (0.4) \cdot \left(\frac{1}{10^5}\right) = 4 \times 10^{-6}$$

And from Figure 4 the fraction of pipe line contaminated

$$F_{10\text{-}90} = 7.25 \times 10^{-3}$$

Therefore the contaminated width

$$W_{10\text{-}90} = (7.25 \times 10^{-3}) \cdot (10^5) = \mathbf{725\ ft.}$$

Problem 5—How would the above found contaminated width be affected if the flow rate is changed to give Re = 1000 and Re = 100,000? Let the average Schmidt number of the two fluids be taken as 385.

Solution—

For the case where Re = 1000

$$(Re) \cdot (Sc) = (1000) \cdot (385) = 3.85 \times 10^5$$

From Figure 3 extrapolated

$$(D/ud) = 2 \times 10^3$$

Therefore

$$(D/uL) = (D/ud) \cdot (d/L) = (2 \times 10^3) \cdot \left(\frac{1}{10^5}\right) = 2 \times 10^{-2}$$

And from Figure 4

$$F_{10\text{-}90} = 0.5$$

So the contaminated width,

$$W = \mathbf{50{,}000\ ft.}$$

For Re = 100,000 we find from Figure 2

$$D/ud = 0.26$$

Then

$$D/uL = (D/ud) \cdot (d/L) = (0.26) \cdot \left(\frac{1}{10^5}\right) = 2.5 \times 10^{-6}$$

From Figure 4

$$F_{10\text{-}90} = 5.86 \times 10^{-3}$$

Hence the contaminated width,

$$W = (5.86 \times 10^{-3}) \cdot (10^5) = \mathbf{586\ ft.}$$

From the last two problems we may generalize:

(1) Streamline flow results in much greater contamination than turbulent flow.

(2) For an increase in flow rate in the streamline region contamination rises with the 0.5 power of the Reynolds number.

(3) For an increase in flow rate in the turbulent flow region contamination decreases, first rapidly and then more slowly.

More complex problems may involve varying flow rates, different pipe sizes in the line, adding product into the contaminated section as it passes a station, etc. Then it may be necessary to deal with a more fundamental measure of the width of the contaminated zone—the variance of the differentiated curve of the S-shaped contamination function of Figure 1. Variances are easy to handle as they may be added, subtracted, etc., hence methods using them may be developed rather easily. Pertinent literature references may be found in a previous report.[2]

There are still many factors in product contamination about which we know embarrassingly little. We need much more good data to accurately locate these curves. We would like to know how bends, fittings, pumps, filters, etc., and non-full pipe gravity flow affect contamination.

Theory was developed considering the lead and following fluids to have identical physical properties. When this is not the case what is meant by the average Reynolds number? We have arbitrarily picked it to be that of the 50 percent-50 percent mixture. But is this the best choice?

Only when the many contributing factors are quantitatively accounted for will we be able to accurately predict product contamination. This will result in better contamination control as well as better pipe line design.

PRODUCT CONTAMINATION is due to the axial mixing of fluids and as such its extent can be predicted theoretically considering velocity profiles, molecular transfer and eddy transport of the material in flow. The result of the analysis indicates that axial mixing may be considered as a diffusion mechanism governed by Fick's Law

$$\frac{\partial c}{\partial \theta} = D\nabla^2 c$$

The constant *D*, called the longitudinal dispersion coefficient, depends on the fluid properties, the physical set up and the flow conditions. For any given situation if the value of *D* is known the above equation may be integrated to allow prediction of the extent of product contamination.

For this report the equation was integrated under appropriate boundary conditions to yield the differential of the S-shaped curve shown in Figure 1. This differential curve approximates the Gaussian error curve for small Du/L (straight line region of Figure 4, or for $D/uL < 0.01$), its variance and standard deviation were determined to prepare Figure 4.

Fuller discussion, justification of the method and references may be found elsewhere.[2]

NOMENCLATURE

- c = concentration of product in fluid
- d = pipe diameter (ft.)
- D = longitudinal dispersion coefficient which characterizes the axial mixing in flowing fluids (ft.²/sec.)
- D_v = molecular diffusion coefficient (ft.²/sec.)
- F = W/L fraction of pipe line length which is contaminated (dimensionless)
- L = length of pipe line, always considered from point of product introduction to distribution station in question (ft.)
- Re = $du\rho/\mu$, — Reynolds number of 50%-50% mixture of the two products flowing successively in the pipe line (dimensionless)
- Sc = $\mu/\rho D_v$, — average Schmidt number of the two fluids flowing successively in the pipe line (dimensionless)
- u = fluid velocity (ft./sec.)
- θ = time
- ρ = fluid density (lbs./ft.³)
- μ = fluid viscosity (lbs./ft. sec.)

LITERATURE CITED

[1] Birge, E. A., *Oil & Gas Journal*, Sept. 20, 1947.
[2] Levenspiel, O., *Ind. and Eng. Chem.*, Vol. 50, No. 3, p. 343 (March, 1958).

About the Author

Octave Levenspiel is an associate professor of chemical engineering at Bucknell University, Lewisburg, Penn. He was born in Shanghai, China, where he attended German, British and French schools. He obtained his B.S. degree in chemistry from the University of California in 1947. He received his M.S. and Ph.D. degrees in chemical engineering from Oregon State College. He has been at Bucknell for the past four years.

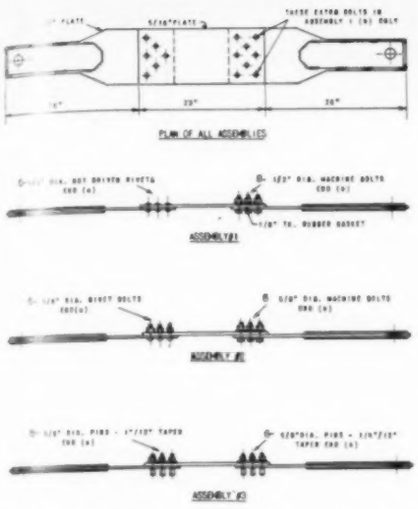


FIGURE 1—Tensile tests of various lap joints indicate that turned bolts in reamed holes work as well as rivets.

Bolted Access Doors Simplify Tank Cleaning

Regular maintenance crews can install and remove new bolted clean-out doors designed for large tanks. New door is safe from stress and will not leak.

By R. W. Bodley and R. C. Ulm
Graver Tank and Manufacturing Company, Incorporated
East Chicago, Ind.

ACCESS DOORS into large tanks are desirable in the storage of certain types of products, especially where clean-out of bottom settlings is necessary. In the past, these openings have been in the form of either riveted door plates or manway-type openings with bolted covers. The bolted doors, which are the subject of this article, are similar in design to the well known riveted type (of which many hundreds have been installed) in that the door-plate is fastened directly to the shell-plate. The riveted types are not used extensively at present because it is difficult to find riveters to replace a door once it has been removed.

The development of bolted door-sheet designs was undertaken as a service to the industry, because there was a need and a desire for a large, safe, economical, clean-out door that could be removed and replaced by regular maintenance personnel. They are not patented or proprietary items.

Several oil companies which expressed the need for these designs also expressed the desire that they carry API approval. Therefore, as this development progressed, the findings were presented to the API Manufacturer's Sub-Committee on Standardization of Oil Storage Tanks, which at the present time is considering final designs for possible inclusion in API Code 12-C.

Test Results. From the results of these tests, it was concluded that bolted clean-outs can be successfully fabricated and installed, do not leak, and are not too highly stressed.

It is our opinion (based on the repeated tests conducted in the shop on $\frac{3}{16}$ inch and $\frac{1}{4}$ inch thick plates) that the doors can be removed at least six times without sufficient damage to the holes or bolts to require reaming or new bolts.

Types of Doors. These clean-out doors are of two types: Raised and flush. The raised type is simply an opening cut in the tank shell with a cover plate bolted over it as in the former riveted type. The flush type is similar except that the bottom of the cover plate is bolted to an angle assembly welded to the underside of the tank bottom so that an opening flush with the tank bottom is obtained when the door-plate is removed. The design of a flush-type door bolting directly to the tank shell without any reinforcing pad plate is new to the art in these large sizes.

The bolts used in this new design are American Standard heavy, machined to size and under the head, so that a good fit is obtained and no lip remains under the head. Square bars are placed between the heads of the bolts in adjacent rows on the inside of the tank to keep the bolts from turning during assembly or removal of the door plate. A neoprene putty gasket containing about 80 percent solids with a specific weight of 12 pounds per gallon is used between the bolting surfaces and around the head of each bolt to seal against leakage.

The door-plate can be initially installed in the field or it can be installed on a shell-plate in the shop, then the plate containing the completed door can be fitted into the tank in the field.

Testing Bolts and Gaskets. As a first step in determining what type of bolts and gaskets would be suitable, six different lapped-type, bolted and riveted joints were made up and tested in a tensile machine. The test assemblies were of $\frac{5}{16}$ inch x 10 inch x 23 inch long center plate with $\frac{1}{4}$ inch x 10 inch x 12$\frac{1}{2}$ inch end plates. Figure 1 shows these assemblies. Before assembly, the bolting surface of each plate was coated with one coat of primer and two coats of neoprene paint except for the riveted joint and joint 1 (b) which contained a $\frac{1}{8}$ inch rubber gasket.

The specimens were covered with a brittle lacquer and then tension was applied until yielding was evident in the plates around the bolts.

From the results of this test, it was concluded that:

- Turned bolts in reamed holes distribute the forces equally as well as rivets in this type of construction.
- Tapered pin bolts are not satisfactory because they loosen after the tension is removed.
- The $\frac{1}{8}$ inch rubber gasket was not satisfactory because it allowed slippage.

- Rivet type bolts (ribbed shanks) are not suitable because they mar the hole in the plate.

Test Doors On a Tank. To further develop bolting and sealing means, tests were run on doors on a 10 foot, 6 inch dia. x 8 foot high tank, which was designed for 50 psi internal pressure. This pressure was selected to simulate at least three times the liquid heads encountered in 40 foot high storage tanks. The tank had a shell $\frac{3}{16}$ inch thick, a top made of a $\frac{3}{8}$ inch thick dished ASME head and a flat, reinforced bottom. Angle ties connected the upper part of the tank to the bottom reinforcing. Besides economy and convenience, this small tank with its thin shell would be harder to seal against leakage than one of thicker plate, and damage to the holes, if any, would show up more quickly with repeated bolt removal. Figure 2 shows a photograph of this tank.

The tank had two test doors, a *flush* type and a *raised* type spaced 180 degrees apart. Each opening was 4 feet high x 8 feet long and the door plate $\frac{1}{4}$ inch thick.

Sealing. Four tests of different sealing means were run as follows on both type doors:

Test 1. The bearing surfaces of the door sheets and shell were covered with one coat of neoprene paint upon which a gasket made of roofing paper was placed. The tank was filled with water and the pressure at the top increased hydrostatically to 35 psig. Leaks around five bolts at that pressure occurred at random locations on the conventional door and several leaks on the flush door occurred at the bottom.

Test 2. A 6 inch length of graphited wicking was wrapped around each bolt on the outside of the door-sheet and underneath the washer and nut, in addition to the gasket in Test 1. This method of sealing the bolts worked satisfactorily to a pressure of 49 psig. However, a leak at a joint in the roofing paper gasket occurred at this pressure. The roofing paper gasket was too hard to handle, so other sealing means were sought.

Test 3. Two coats of neoprene paint were applied on each bearing surface of the flush door-sheet and the shell. A neoprene strip $\frac{1}{16}$ inch x $\frac{3}{4}$ inch wide was attached to the raised door plate all around its outer edges. Wicking was wrapped around all bolts on both doors as in Test 2.

The flush door with the four coats of neoprene paint did not leak at 45 psig. The conventional door, with the strip gasket, leaked as a result of water head only.

Test 4. A full face gasket appeared to be necessary, so a search for a thicker paint was launched. A neoprene trowelling compound was found and applied to both bearing surfaces. Wicking was applied to only a few new bolts for purposes of comparison. This was tested to a pressure of 50 psig, which is equal to a water height of approximately 115 feet, and no leaks occurred.

At the conclusion of these four tests, sealing was finally accomplished by applying a $\frac{1}{16}$ inch coating of neoprene to the $\frac{3}{16}$ inch shell and $\frac{1}{4}$ inch door-plate.

The same bolts and nuts were used in all four tests and no additional

FIGURE 2—Test tank designed for three times the head encountered in a 40-foot high storage tank.

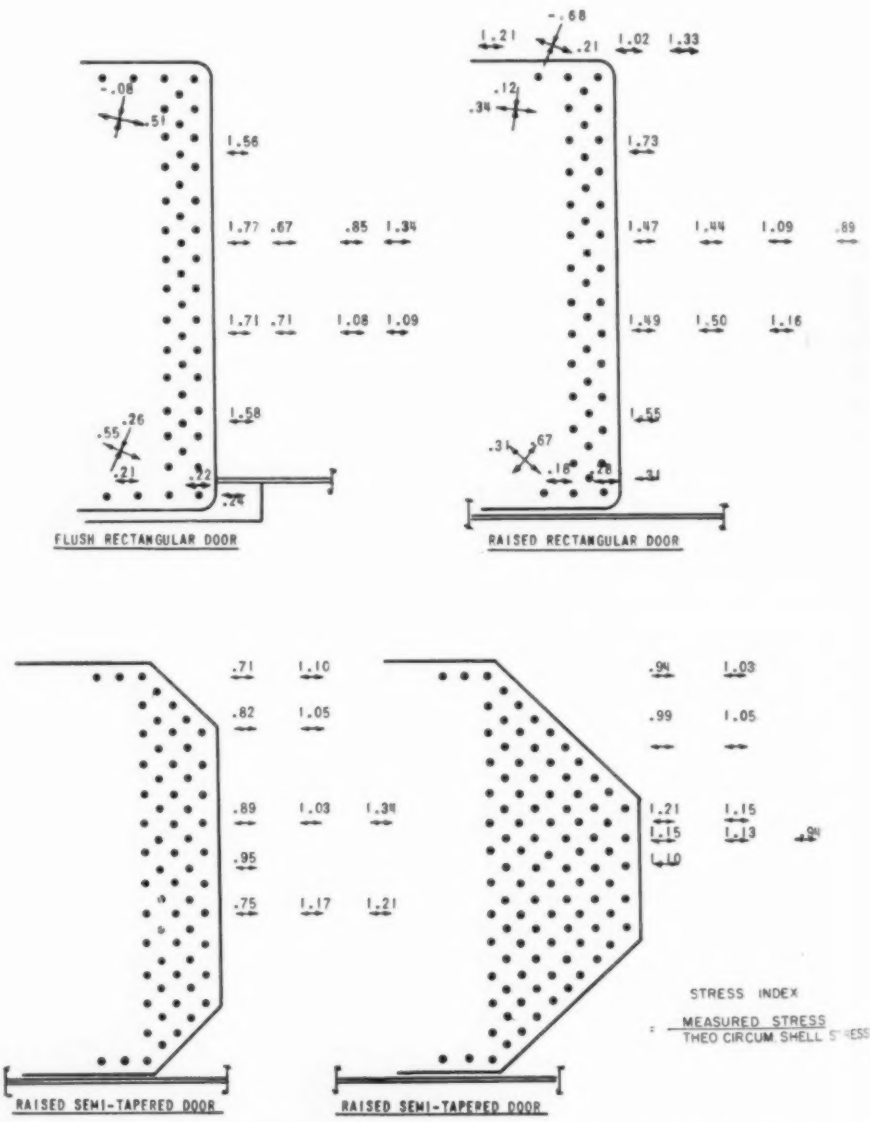


FIGURE 3—Stress indices on test doors show that doors can be bolted without excessive stress concentrations.

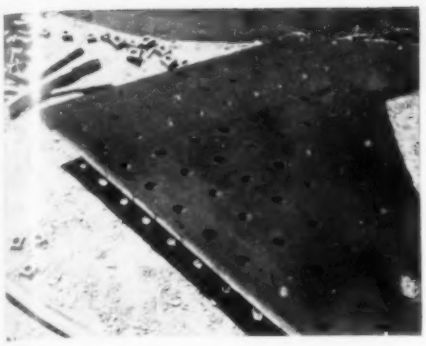


FIGURE 4—Neoprene gasket is trowelled on door and allowed to become tacky.

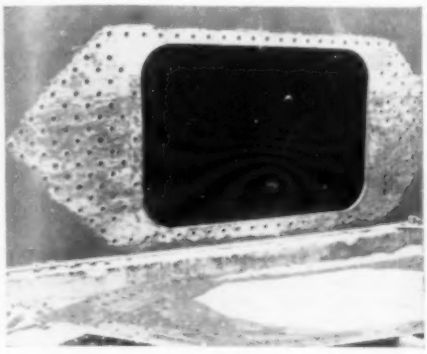


FIGURE 5—Mill scale is ground off the shell plate around the clean-out opening.

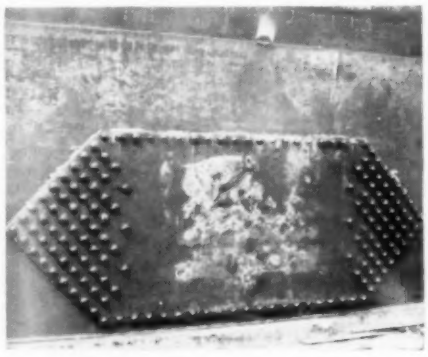


FIGURE 6—Clean-out door bolts are tightened with an air wrench.

reaming was required to rebolt the door nor was any hole damage observed.

Design. As the method for sealing was being developed, designs of the doors were also being studied. Rectangular doors were used on the first three tests on both the flush and raised types. On the fourth test, a door with a semi-taper on one end and almost a full taper on the other end was used.

Strain gages, both Rosette and A-5, were mounted outside the tank at various positions around the doors with the intention of covering all points of stress concentration. The total strain gage circuits employing strain indicators were used.

Indicated strains for each gage were plotted against pressure for each of the above tests. Lines were carefully faired through the experimental points. A dashed line parallel to the above lines was drawn through zero and projected to the 50 psig position. Strains corresponding to this pressure were used in the calculations.

Rosette gages were analyzed algebraically to determine principal stresses and directions. Each stress calculated in the above manner was divided by the theoretical circumferential shell stress to give a stress index. Some of these index values are shown in their respective positions on the door-sheets in Figure 3. The arrow shows the directions of the measured stress.

The stress indices for the various tests indicated:

- Near the bottom of the shell, for the raised type door, or on the bottom angle for a flush type door, a plate could be satisfactorily bolted without any stress concentration.
- Along the top of the plate and near the upper corners, the stresses were transmitted from the door to the shell with a stress build-up of less than 21,000 psi.
- Excessive stress concentrations were present in the shell at the ends of the rectangular sheets. This could be reduced by fully tapering the sheets.

Field Tests. Since the foregoing preliminary tests yielded favorable results, a program of installing and testing these door-sheets on field-erected tankage was undertaken. Two raised-type and two flush-type doors were installed. The raised doors were 4 feet x 6 feet installed in a 140 foot diameter, center-weighted, floating roof tank. One of these was strain gage tested. The flush doors were also 4 feet x 6 feet. One was installed in a 67 foot dia. x 40 foot cone roof tank and the other in a 100 foot dia. x 40 foot cone roof tank. Both were strain gage tested.

Installation. The two raised-type doors were bolted to the shell-plate in the field. The flush-type doors were assembled to the shell plate and bottom girder in the shop, and this assembly was then welded into the first ring of the shell in the field. Both methods worked well. On the shop-assembled units, stiffening angles were tacked to the shell-plate to protect the assembly during shipment.

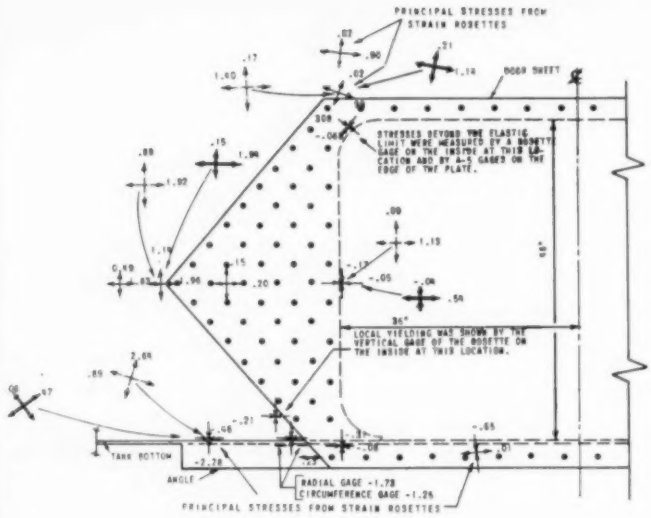
American Standard, milled-body machine bolts with heavy hexagon heads and heavy hexagon nuts were used. The holes were drilled $\frac{1}{8}$ inch undersize and then reamed to the exact bolt diameter, after the door was "fit-up." Square bars bearing against the bolt heads were tack welded to the shell inside, to prevent the bolts from turning during assembly or removal. Tacks were placed directly opposite the bolt heads, to prevent the bar from bending and allowing the bolt to turn.

The door was then removed, the bearing surfaces were brushed free of dirt and scale and a gasket of neoprene, trowelling compound accelerator, about $\frac{1}{16}$ inch thick, was applied to the bearing surface of the door only. This is in contrast to the small tank tests in which the compound was placed on both bearing surfaces. The compound was applied with a saw toothed applicator similar to one used for spreading lineoleum paste (See Figures 4 and 5). A fillet of this compound was placed around the shank, at the head of each bolt, before the bolts were inserted into the holes. About 12 pounds of this compound was used for each door. The bolts were tightened with an air wrench. Figure 6 shows a door bolted in place.

Testing. The strain gages were mounted in the same manner as that described above for the small tank tests, except that the gages were mounted both inside and outside the shell, opposite each other, so that average membrane stresses could be obtained. Also, in the case of the A-5 gages, two gages were mounted at right angles to each other, one horizontally and one vertically at each location. The normal solution for the case of strains in tension or compression in two perpendicular directions was used in analyzing the results from these gages. Wood frame sunshades were built around the sheets to protect the gages from direct sunlight and thereby minimized the chances for large errors in measured stresses resulting from high temperature gradients.

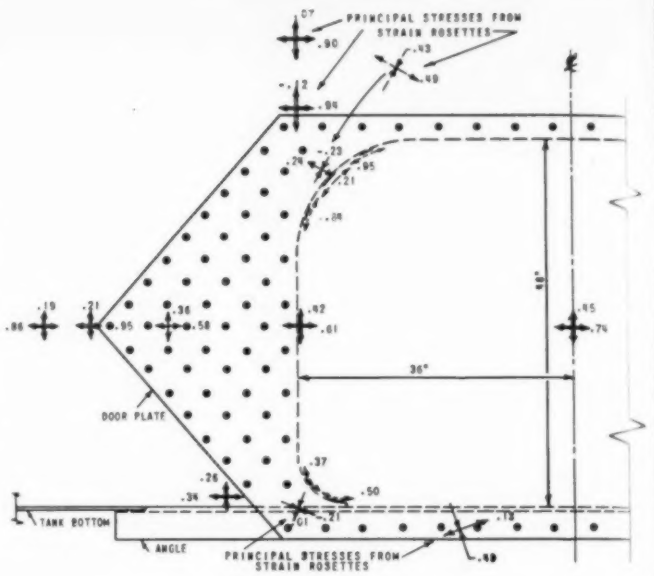
Careful and repeated observations indicated that there were no leaks on any of the doors.

Indicated strains were handled in a manner similar to that described


PRINCIPAL STRESSES FROM STRAIN ROSETTES
DOOR SHEET
STRESSES BEYOND THE ELASTIC LIMIT WERE MEASURED BY A DEMEC GAGE ON THE INSIDE AT THIS LOCATION AND BY A-5 GAGES ON THE EDGE OF THE PLATE.
36"
LOCAL YIELDING WAS SHOWN BY THE VERTICAL GAGE OF THE ROSETTE ON THE INSIDE AT THIS LOCATION.
TANK BOTTOM
ANGLE
RADIAL GAGE -1.73
CIRCUMFERENCE GAGE -1.25
PRINCIPAL STRESSES FROM STRAIN ROSETTES

Note: Stress indices in a 4-foot by 6-foot flush type cleanout on a 67-foot diameter by 40-foot high tank. Dashed arrows refer to stresses measured on the inside of the tank. Solid arrows show gage location and refer to stresses measured on the outside of the tank. Where a double line is used the arrows refer to the membrane or average stress. Numbers are stress indices i.e. measured stresses divided by the nominal theoretical hoop stress one foot above the tank bottom. Negative signs indicate compression.

FIGURE 7—The upper corner of the shell plate was stressed beyond the elastic limit in one test.



Note: Stress indices in a 4-foot by 6-foot flush type cleanout on a 100-foot diameter by 40-foot high tank. Dashed arrows refer to stresses measured on the inside of the tank. Solid arrows show gage location and refer to stresses measured on the outside of the tank. Where a double line is used the arrows refer to the membrane or average stress. Numbers are stress indices i.e. measured stresses divided by the nominal theoretical hoop stress one foot above the tank bottom. Negative signs indicate compression.

FIGURE 8—The shell plate radius was increased which relieved the high stress concentrations of the previous tests.

above for the small tank tests. In this case, the stress indices were obtained by dividing the measured stress by the theoretical circumferential shell stress at a point one foot above the tank bottom.

In general, the results of this investigation showed that the measured values of stress were consistent with what would be expected from theoretical considerations. The measured circumferential membrane stress was near the calculated value in the shell-plate and door-sheet.

Stresses near the bottom were generally low. This was expected since the bottom plates take some of the tension and consequently, lowers the hoop stress in that region. However, considerable vertical compressive stress (80 percent of the nominal hoop stress) was measured near the bottom on one test. This is consistent with what we expected from a consideration of the expansion of the shell above the constraint at the bottom.

A Rosette gage on the shell plate, close to the upper curved corner of the opening, showed high stress concentration in that area on the first test and strains above the elastic limit on the second test. Stress indices showing this for Test 2 are plotted in position on Figure 7. To alleviate this condition, the upper corner radius was increased from 6 inches to 16 inches for Test 3. Indices for this test are shown plotted in Figure 8. Study of this figure shows that the high stress concentration was relieved.

Bolted Door Design. The design of the test doors described above was based on an 85 percent joint efficiency with an allowable stress of 21,000 psi in the plate. Because of possible damage to the holes by repeated removal of the door, the API committee requested that the joint efficiency be increased to 90 percent to allow for additional reaming.

The design rules which follow call for a 90 percent efficiency and represent the latest data submitted to the API. The tabulations (Figures 9 and 10 and Tables 1 and 2) are for doors 4 feet high by 8 feet long. Other sizes may be calculated as desired. The door plate in the tabulation is thicker than the shell-plate because less steel is required than for plates the same thickness as the tank shell. Other door-plate thicknesses and bolt arrangements can be safely used if the following rules are met.

Rules.

1. The strength of the bolted joint should be equal to at least 90 percent of the full strength of the unbolted plate.
2. Maximum tensile stress in net section or door-plate equals 21,000 psi.
3. Maximum shear stress in gross section of bolt equals 16,000 psi.
4. Maximum bearing stress on plate or bolts equals 32,000 psi.
5. The minimum net cross-sectional area of the door-sheet, excluding the tapered ends, shall not be less than the product of the shell-plate thickness and the vertical height of the cutout in the tank shell plus twice the bolt-hole diameter.
6. Provide sufficient bolts to transmit

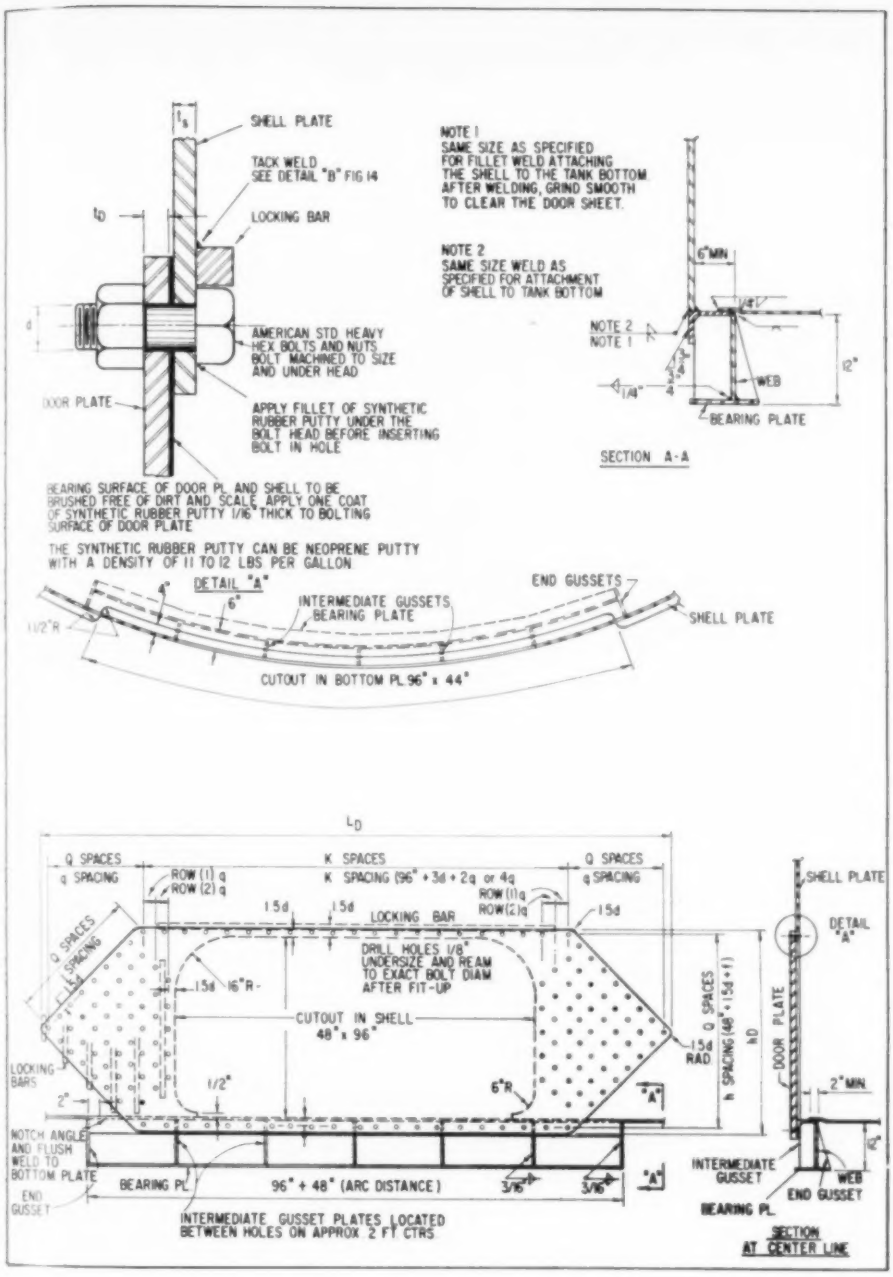

SHELL PLATE
TACK WELD SEE DETAIL "B" FIG 14
LOCKING BAR
AMERICAN STD HEAVY HEX BOLTS AND NUTS BOLT MACHINED TO SIZE AND UNDER HEAD
DOOR PLATE
APPLY FILLET OF SYNTHETIC RUBBER PUTTY UNDER THE BOLT HEAD BEFORE INSERTING BOLT IN HOLE
NOTE 1
SAME SIZE AS SPECIFIED FOR FILLET WELD ATTACHING THE SHELL TO THE TANK BOTTOM AFTER WELDING, GRIND SMOOTH TO CLEAR THE DOOR SHEET.
NOTE 2
SAME SIZE WELD AS SPECIFIED FOR ATTACHMENT OF SHELL TO TANK BOTTOM
6" MIN
NOTE 2
NOTE 1
1/4"
WEB
12"
BEARING PLATE
SECTION A-A
BEARING SURFACE OF DOOR PL AND SHELL TO BE BRUSHED FREE OF DIRT AND SCALE. APPLY ONE COAT OF SYNTHETIC RUBBER PUTTY 1/16" THICK TO BOLTING SURFACE OF DOOR PLATE
THE SYNTHETIC RUBBER PUTTY CAN BE NEOPRENE PUTTY WITH A DENSITY OF 11 TO 12 LBS PER GALLON
DETAIL "A"
6"
END GUSSETS
INTERMEDIATE GUSSETS
BEARING PLATE
SHELL PLATE
1 1/2"R
CUTOUT IN BOTTOM PL 96" x 44"
Q SPACES
q SPACING
ROW (1) q
ROW (2) q
K SPACES
K SPACING (96" + 3d + 2q or 4q
Q SPACES
q SPACING
ROW (1) q
ROW (2) q
15d
15d
LOCKING BAR
15d
SHELL PLATE
DETAIL "A"
DRILL HOLES 1/8" UNDERSIZE AND REAM TO EXACT BOLT DIAM AFTER FIT-UP
15d 16"R
CUTOUT IN SHELL 48" x 96"
Q SPACES h SPACING (48" + 15d + f)
15d RAD
hD
DOOR PLATE
LOCKING BARS
1/2"
6"R
"A"
2" MIN
NOTCH ANGLE AND FLUSH WELD TO BOTTOM PLATE
END GUSSET
BEARING PL
96" + 48" (ARC DISTANCE)
3/16
3/16
"A"
INTERMEDIATE GUSSET
WEB
END GUSSET
BEARING PL
INTERMEDIATE GUSSET PLATES LOCATED BETWEEN HOLES ON APPROX 2 FT CTRS
SECTION AT CENTER LINE

FIGURE 9—Raised-type bolted door sheets. (See Table 1)

to the door plate, by shear, 90 percent of the full strength of the unbolted shell-plate.

7. The bolts can be arranged in various patterns providing the arrangement produces tapered ends. The minimum distance between centers of bolt holes shall be at least three times the nominal diameter of the bolt. The tensile stress of the net plate in the first row of bolts next to the shell opening shall not exceed 21,000 psi and in subsequent rows shall not exceed 21,000 psi less the total shearing value or bearing value (whichever is less) of the bolts in the preceding row or rows. (In certain cases, where thinner plates are encountered, the bearing value may govern and should be checked.) Bolt spacing at the sealing edge of the plate shall not exceed seven times the minimum door-sheet thickness (plus washer thickness if washers are used) plus the nominal diameter of the bolt.

From the above:

Flush type door $N =$

$$\frac{t_s\,(h_c + 2.5d + f) \times 21{,}000 \times 0.90}{A \times 16{,}000}$$

Raised type door $N =$

$$\frac{t_s\,(h_c + 4d) \times 21{,}000 \times .90}{a \times 16{,}000}$$

$$t_D = \frac{t_s(h_c + 2d)}{h_D - (N_1 d)}$$

Where:

N = Number of bolts required at each end of opening
t_s = Shell-plate thickness, inches
t_d = Door-plate thickness, inches
h_D = Height of door-plate, inches
h_c = Height of shell cutout, inches
d = Diameter of bolt and bolt holes, inches
a = Area of bolt and bolt holes, square inches
N_1 = Maximum number of bolts in any one row.

8. If the difference between the diameter of the bolts and the holes

TABLE 1—Raised-Type Bolted Door-Sheets

See Fig. 9—All Dimensions in Inches

Shell Thickness	Q	q	h	j	K	k	t_D	h_D	L_D	NO. OF BOLTS Row 1	Row 2	Total	Dia. of Bolt d	Length of Bolt	Bolt Thread Length	Square Locking Bar	Max. Dia. Re-Reamed Hole
3/16	7	1 1/16	7.179	4.080	36	2.837	7/16	52 1/2	1317/16	5	...	152	3/4	2	1 1/8	5/8	1
1/4	7	1 1/16	7.179	4.080	30	3.404	7/16	52 1/2	1317/16	7	...	144	3/4	2	1 1/8	5/8	1
5/16	8	1 1/16	6.281	3.691	30	3.404	7/16	52 1/2	1357/16	8	...	164	3/4	2	1	5/8	1
3/8	8	2 1/16	6.328	3.883	24	4.109	1/2	53 1/4	1373/4	...	...	136	7/8	2 1/4	1 1/16	3/4	1 1/16
7/16	8	2 1/16	6.328	3.883	22	4.688	7/16	53 1/4	1423/4	6	...	144	7/8	2 1/2	1 1/4	3/4	1 1/16
1/2	8	2 1/16	6.375	4.012	20	4.950	5/8	54	1418/8	...	...	128	1	2 3/4	1 3/8	3/4	1 1/4
9/16	8	2 1/16	6.375	4.012	20	5.194	5/8	54	1463/8	4	...	136	1	2 1/2	1 1/4	3/4	1 1/4
5/8	8	2 5/8	6.422	4.309	20	4.969	11/16	54 5/8	1493/4	...	...	128	1 1/8	2 3/4	1 3/8	1	1 3/8
11/16	8	2 5/8	6.422	4.309	20	5.256	11/16	54 5/8	1555/8	2	...	132	1 1/8	3	1 1/2	1	1 3/8
3/4	8	3 1/16	6.469	4.453	20	4.988	11/16	55 1/2	1533/8	...	...	128	1 1/4	3 1/4	1 3/8	1	1 1/2
13/16	8	3 1/16	6.469	4.453	20	4.988	1	55 1/2	1533/8	...	...	128	1 1/4	3 1/4	1 1/2	1	1 1/2
7/8	8	3 1/16	6.469	4.453	20	5.294	1 1/16	55 1/2	1601/8	6	...	140	1 1/4	3 1/2	1 7/16	1	1 1/2
15/16	8	3 1/16	6.469	4.453	20	5.600	1 1/8	55 1/2	1663/4	8	5	154	1 1/4	3 3/4	1 1/2	1	1 1/2
1	8	3 1/4	6.516	4.602	20	5.656	1 1/8	56 1/4	171	6	3	146	1 3/8	4 1/4	1 5/8	1	1 5/8
1 1/16	8	3 1/4	6.516	4.602	20	5.656	1 1/16	56 1/4	171	8	7	158	1 3/8	4 1/2	1 7/16	1	1 5/8
1 1/8	8	3 1/16	6.563	4.754	20	5.712	1 1/16	57	175 3/4	6	5	150	1 1/2	5	1 1/16	1	1 3/4

NOTE: Use American Standard washers on both sides of plate up to 5/8-inch shell thickness.

TABLE 2—Flush-Type Bolted Door-Sheets See Fig. 10—All Dimensions in Inches

Shell Thickness t	Q	e	h	j	K	k	t_D	h_D	f	L_D	NO. OF BOLTS Row 2	Row 1	Total	Diam. of Bolt d	Length of Bolt	Bolt Thread Length	Sq. Lock Bar	Max. Diam. Re-Reamed Hole	Angle	Web	Intermediate Gusset	End Gusset	Bearing Plate
3/16	7	1 1/16	7.375	4.165	36	2.837	7/16	5 3/8	1/4	132	7	1	156	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1/4	7	1 1/16	6.453	3.766	30	3.275	7/16	5 3/8	1/4	132	6	1	136	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
5/16	8	1 1/16	6.453	3.766	30	3.401	7/16	5 3/8	1/4	136	6	1	161	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
3/8	8	1 1/16	6.453	3.766	24	4.297	7/16	5 3/8	1/4	142	6	1	138	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
7/16	8	1 1/16	6.477	3.945	22	4.892	7/16	5 3/8	1/4	146	6	1	148	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1/2	8	1 1/16	6.477	3.945	22	5.194	7/16	5 3/8	1/4	146	6	1	130	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
9/16	8	1 1/16	6.500	4.063	20	5.194	7/16	5 3/8	1/4	146	6	1	138	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
5/8	8	1 1/16	6.500	4.063	20	5.194	7/16	5 3/8	1/4	146	6	1	126	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
11/16	8	1 1/16	6.586	4.371	20	4.969	7/16	5 3/8	1/4	155/8	4	1	134	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
3/4	8	1 1/16	6.586	4.371	20	5.256	7/16	5 3/8	1/4	151	4	1	125	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
13/16	8	1 1/16	6.809	4.504	20	4.988	7/16	5 3/8	1/4	160	2	1	130	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
7/8	8	1 1/16	6.809	4.504	20	5.294	7/16	5 3/8	1/4	166 1/4	6	1	144	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
15/16	8	1 1/16	6.809	4.504	20	5.600	7/16	5 3/8	1/4	164 1/2	6	1	138	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1	8	1 1/16	6.833	4.645	20	5.383	7/16	5 3/8	1/4	171	6	1	148	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1 1/16	8	1 1/16	6.833	4.645	20	5.656	7/16	5 3/8	1/4	175/8	6	1	144	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1 1/8	8	1 1/16	6.833	4.645	20	5.713	7/16	5 3/8	1/4	175/8	6	1	148	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1 3/16	8	1 1/16	6.856	4.785	20	5.713	7/16	5 3/8	1/4	175/8	6	1	148	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8
1 1/4	8	1 1/16	6.856	4.785	20	5.713	7/16	5 3/8	1/4	175/8	6	1	148	3/4	2 1/2	1 1/16	5/8	1	6x4x3/8	1x11/16	1x5 x11/16	1x8x11/16	1x8

NOTE: Use American Standard washers on both sides of plate up to 5/8-inch shell thickness. • Special length bolts shall be furnished for bolting the bottom of the door sheet to the supporting truss.

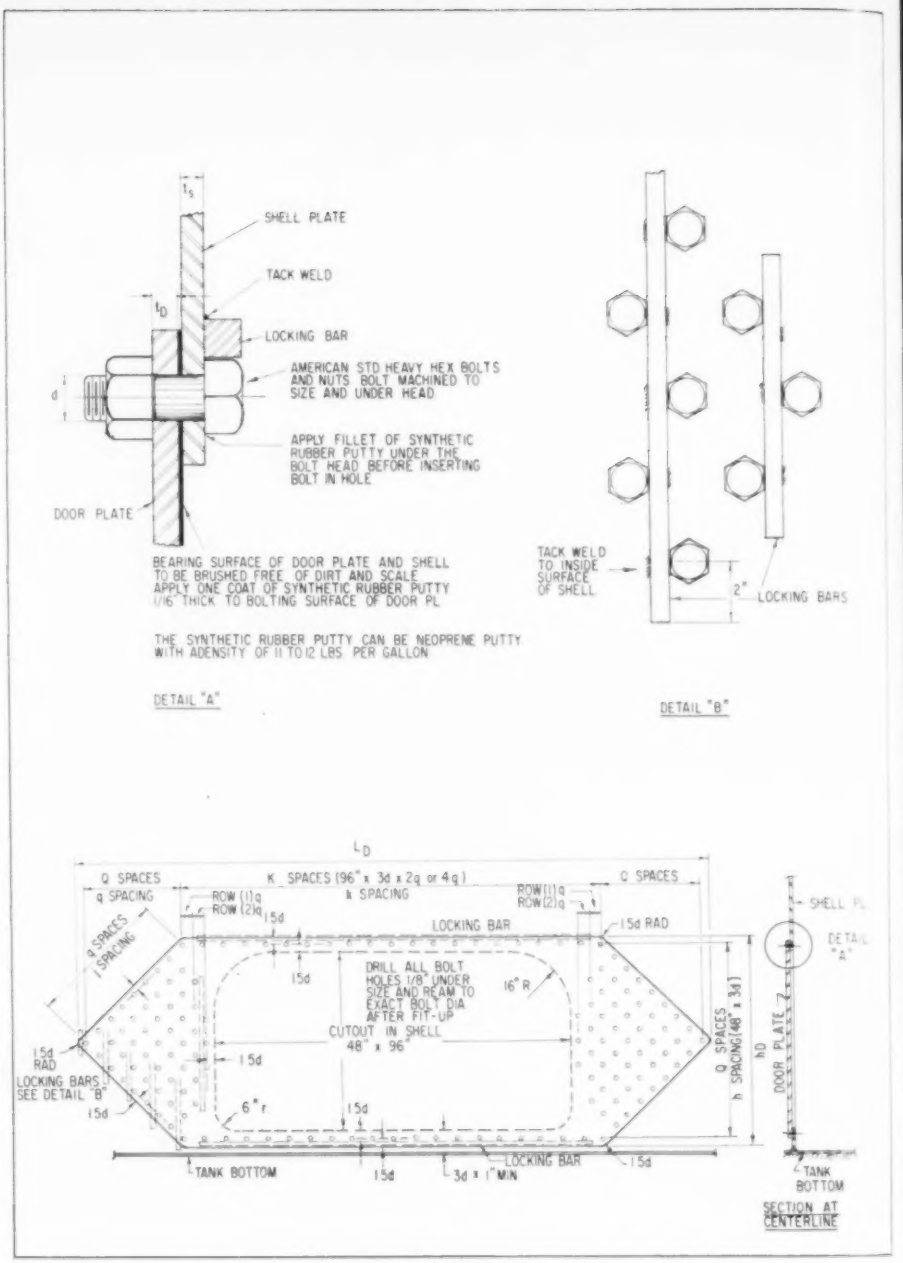

SHELL PLATE
TACK WELD
LOCKING BAR
AMERICAN STD HEAVY HEX BOLTS AND NUTS BOLT MACHINED TO SIZE AND UNDER HEAD
APPLY FILLET OF SYNTHETIC RUBBER PUTTY UNDER THE BOLT HEAD BEFORE INSERTING BOLT IN HOLE
DOOR PLATE
BEARING SURFACE OF DOOR PLATE AND SHELL TO BE BRUSHED FREE OF DIRT AND SCALE APPLY ONE COAT OF SYNTHETIC RUBBER PUTTY 1/16" THICK TO BOLTING SURFACE OF DOOR PL
THE SYNTHETIC RUBBER PUTTY CAN BE NEOPRENE PUTTY WITH ADENSITY OF 11 TO 12 LBS PER GALLON
DETAIL "A"
TACK WELD TO INSIDE SURFACE OF SHELL
2" LOCKING BARS
DETAIL "B"
Q SPACES
q SPACING
K SPACES (96" x 3d x 2q or 4q)
k SPACING
ROW (1) q
ROW (2) q
15d
LOCKING BAR
15d RAD
DRILL ALL BOLT HOLES 1/8" UNDER SIZE AND REAM TO EXACT BOLT DIA AFTER FIT-UP
16" R
CUTOUT IN SHELL 48" x 96"
15d RAD
LOCKING BARS SEE DETAIL "B"
6" r
TANK BOTTOM
3d x 1" MIN
DOOR PLATE
SECTION AT CENTERLINE

FIGURE 10—Flush-type bolted door-sheets. (See Table 2)

becomes greater than 1/50 inch, because of repeated removal of the door, the holes should be re-reamed to a larger size and new bolts should be provided. The holes should not be reamed beyond the point where the strength of the bolted joint becomes less than 85 percent of the full strength of the unbolted plate.

9. Round all door-plate corners to a minimum radius of 1½d.

10. Bottom girder for flush type door:

(a) The girder to withstand a bending moment which would result if the ends of the girder were on hard ground and the center was unsupported.

(b) Consider the load on the girder to be equal to the weight of a column of water with the dimensions: .03 tank radius x width of shell cutout + 2 feet tank height.

(c) The design length of the girder should be equal to the width of the shell cutout + 2 feet.

(d) In Table 2, the bottom angle thickness is made equal to the shell-plate thickness where possible, so that special length bolts are not required.

ACKNOWLEDGMENT

The authors wish to express their gratitude to the various oil and chemical companies who made the field tests possible and the API Committees on Standardization of Oil Storage Tanks for constructive suggestions.

At right, the first 32-foot section of twin 62-inch road casing is jacked into place by air powered jack. Notched rails and specially designed travelling backstops used by BorTunCo reduced setup time for each push to a minimum. As additional lengths of casing were added, it was necessary to pour concrete around the rails to prevent buckling.

Welders have completed line-up and welding of another joint to casing on left. Jacking equipment and excavation crew will then be shifted to left hand casing to push it into position while another joint is welded on at right. Operations were continuous "around the clock" to prevent "freezing" of the casing in the rock-soil fill.

Mining Methods Used on Giant Road Crossing

Dual 62-inch crossings were jacked under roads on Carnegie Natural Gas' new Pennsylvania line. Toughest "tunnelling" job was 135-foot-long casing installation with a 1-inch tolerance specified in an 8-foot grade rise.

THERE IS more than one way to make a pipe line road crossing. To install 55- and 62-inch casings for Carnegie Natural Gas Company's new line between Clairton and Homestead, Pa., Boring and Tunnelling Company of America resorted to mining methods to get the casing job done.

Photo above shows a typical "push" sequence. First, a 32-foot long casing section was started under the bed of Carnegie Hollow Road. Line-up had to be carefully controlled in the 135-foot crossing to meet an allowable deviation of 1-inch in an 8-foot grade rise. Operations continued around the clock to prevent "freezing" of the casing in the soil-rock bore.

As the casing was forced under the roadbed, miners excavated the dirt and rock from the face of the bore with conventional mining tools. Spoil was hauled out of the casing in a 1-yard mine cart and dumped by crane.

Installation of dual casings actually helped to speed up operations; while a new section was being lined-up and welded on to one casing, crews shifted to the other to jack it into place. Air powered jacks supplying 200 tons of driving pressure were used to drive the 62-inch casings into place. As the jack worked along the notched railway, specially designed travelling backstops reduced the set-up time for each "drive." When casing length increased beyond two sections, it was necessary to pour concrete around the rails to prevent them from buckling under the increasing load.

Pipe used for the 62-inch casings was of ½-inch wall. In the job there are 6 dual 62-inch crossings, 2 dual 55-inch and 5 single 30-inch crossings.

The 30-inch casings will be installed with conventional road boring equipment. Although a larger number of "super-inch" crossings of the future will undoubtedly bring about the development of large boring machinery, speed and versatility of experienced tunnelling crews are now the most practical means of handling the big jobs within close tolerances needed.

Williams Brothers Company is the prime contractor for the construction of the 43 and 55-inch pipe line project. Texas Tunnelling Company and Horizontal Holes, Inc., divisions of BorTunCo are installing the casings for road and railroad crossings as subcontractors. —**The End**

Part 1

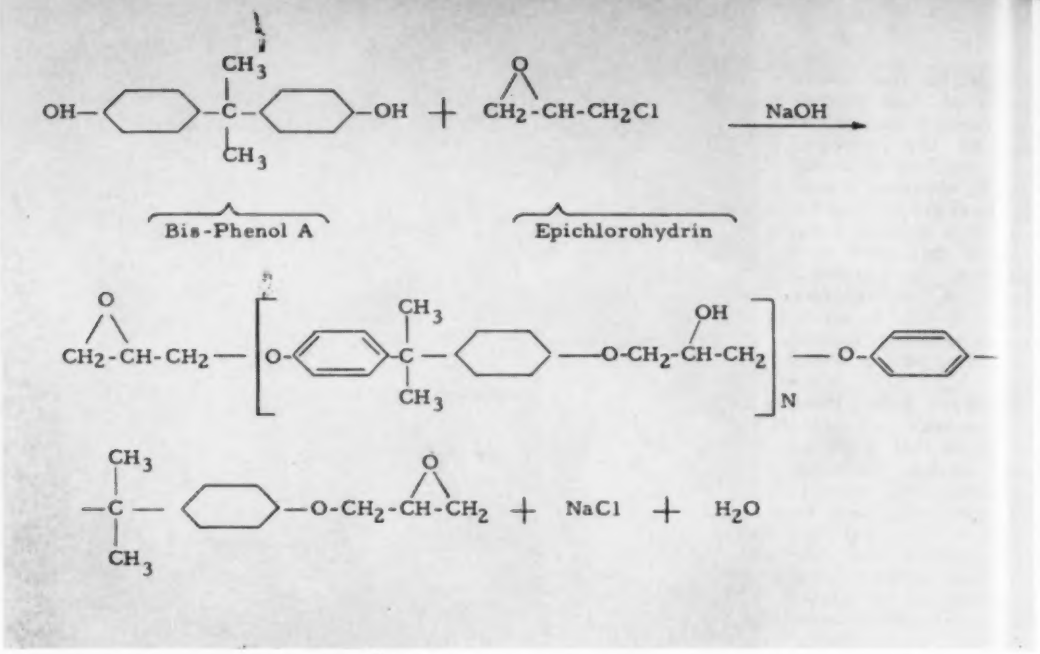


FIGURE 1—Epoxy resins are condensation products of bis-phenol A and epichlorohydrin in the presence of sodium hydroxide. Molecular weights will range from 624 up. The simplest resins are liquid, but above values of n = 2 they are solids.

Thin Films Coatings—What They Are

Field tests indicate coal tar-epoxies will be the first practical "thin film coating" for underground protection of pipe lines. Here is some of the chemistry behind the development of this important new coating.

By N. T. Shideler and F. C. Whittier
Pittsburgh Coke and Chemical Company
Pittsburgh, Penn.

DEVELOPMENTS in the direction of better coatings for pipe lines have been intensified since 1945 due to the rapid development of new synthetic resins and related materials. The most significant new coating materials introduced have been plastic tapes, either of the polyethylene or polyvinyl types, extruded polyethylene coating on pipe of small diameter and a closely related development—plastic pipe produced by the use of a variety of resins, modified resins, and glass mat.

Tapes apply easily on straight sections of pipe but it is very difficult to successfully protect valves and fittings with tape because of the odd shapes. Extruded polyethylene on steel pipe has certain advantages. However, for both the tapes and extruded plastic on steel, there is still the difficulty of good adhesion, resistance to puncture and chemical damage, protection of joints, fittings and valves, and inability of such products to stand moderately high temperatures.

Thin film coatings such as baked phenol-formaldehyde coatings and vinyl resin coatings have been tried. The phenol-formaldehyde coatings have been successfully used in oil well tubing, sucker rods and well casings where the corrosive condition is severe enough to warrant this expensive application requiring multiple coats and multiple bakings. The vinyls likewise cannot be applied in thick films except by application of multiple coats requiring drying time between coats.

Hot Applied Enamels Still Most Common. Hot applied coatings or enamels have been the predominant coating used on underground pipe lines for more than 50 years. High electrical and corrosion resistance and resistance to moisture penetration have made them superior for this service throughout the years. Undoubtedly, they will continue to be the major coatings in this field for many more years despite some limitations. All coatings systems have certain disadvantages. Major disadvantages of enamel coatings are:

- The large amount of major equipment required for application.
- Although not a serious problem, the necessity of working with molten materials at temperatures up to 500° F. is somewhat dangerous.
- Inability to completely resist the effects of soil stress, mechanical damage and danger of puncture of the coating by stones, clods, and other hard objects in the backfill and pipe trench.
- Necessity for primer requires double handling of the pipe and careful co-ordination between application of primer and enamel to obtain maximum adhesion.

Hot applied coatings have been im-

proved through the years. They have better temperature susceptibility, greater resistance to soil stress, less danger of damage to the coating during application and no doubt will be further improved in the years to come.

Properties for Ideal Coating. Having outlined some of the limitations of hot applied coatings, following are some of the properties which should be exhibited by the ideal coating.

- A coating that is easily applied, preferably in one coat that will set up rapidly so that coated pipe can be handled with normal care without danger of damaging the coating.
- High electrical resistance or insulating values.
- Permanent resistance to moisture, total immersion, mild acids, alkalies, and heat.
- A coating tough enough to prevent the action of soil stress, puncture or physical damage.
- A coating that will stand temperatures as low as minus 40° and as high as 300° F.
- A coating that does not soften at elevated temperatures.
- A coating that is not attacked by petroleum or other chemicals which may contaminate soil around the pipe line.
- Maximum adhesion to the properly cleaned bare metal.

Coating Film—How Thick? Hot applied enamels are applied never less than $\frac{1}{16}$-inch thick and preferably $\frac{3}{32}$-inch. Tapes vary from 10-mil to 20-mil thickness, and the phenol-formaldehyde baked coatings applied in multiple coats are from 5 to 7 mils thick. Required coating thickness is probably a function of:

- Adhesion characteristics
- Corrosion resistance of coating
- Permanence of the coating itself
- Anchor pattern of metal surface
- Single or multiple coats

A coating may have good adhesion by molecular attraction, mechanical anchoring or both. True molecular adhesion is preferred for pipe line coatings, since some pipe cleaning methods do not produce sufficient anchor for firm mechanical adhesion. Anchor pattern is quite important in considering thin film coatings since the depth of anchor detracts from total film thickness. A 7-mil coating applied over a 3-mil anchor pattern leaves only 4 mils actual coating over the peaks of the anchor pattern.

Number of Coats Important for Thin Films. The question of single or multiple coats is quite pertinent in considering cold applied coatings. A 7-mil film of phenol-formaldehyde baked coating normally requires from 4 to 5 coats. If it were possible to build up the solids in this coating to make the application in one coat, the resultant coating would probably show numerous voids while the multiple coat system would show none. This variance is not a fault of the coating but is due to normal characteristics of cold applied coating application. Stirring of the coating, brush, spray or other methods of application introduce air bubbles, sometimes moisture and occasionally dust into the coating. Thus, the single coat application must be greater than the thickness of a multiple coat application to eliminate or cover these imperfections. In the multiple coating systems, these are covered by successive coats.

The optimum coating thickness becomes a function of the nature of the coating, the application and the anchor pattern. With normal mill and field application methods, the thickness should be not less than 20 mils if applied in one coat or 15 mils if applied in two coats.

Coal Tar-Epoxies Are Close to Ideal Coating. It would appear in looking at the list of requirements for an ideal coating, that it is almost impossible to obtain all of these requirements. However, recent developments using epoxy resins combined with coal tar or coal tar pitch indicate that with further development and refinement, most of the requirements can be attained.

At one time or another, practically all of the synthetic resins have been tried in coal tar coatings with varying degrees of success. Many were found to be incompatible with the coal tar system, while others, like the phenol-formaldehyde resins, showed promise but exhibited disadvantages such as formation of water or other by-products detrimental in the cured film.

With the introduction of the epoxy resins about 10 years ago, a promising material was made available for a cold applied coal tar-synthetic resin coating system. These resins are capable of room temperature cure, are compatible with coal tar and produce no by-products on curing.

What Are Epoxy Resins? Commercially available epoxy resins used today are condensation products of a dihydroxy phenol, generally bisphenol A, and epichlorohydrin in the presence of sodium hydroxide.

The "n" radical shown in Figure 1 is the repeating radical in the molecule and is controlled by varying the mol ratios of the reactants. The simplest resin in which n=0 will have a molecular weight of 340. Since the molecular weight of the "n" radical inside the bracket is 284, where n=1 the molecular weight of the resin would be 624; for n=2, 908; for n=3, 1192, etc.

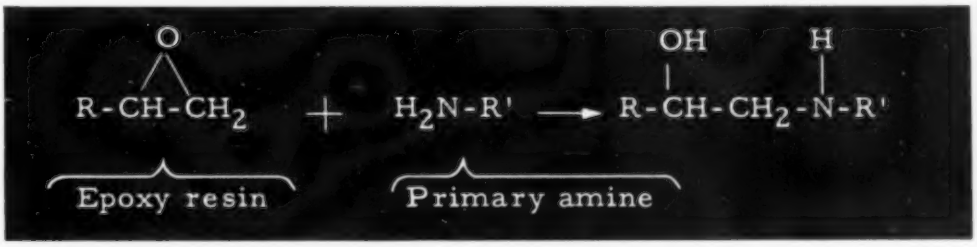


FIGURE 2—Polyfunctional primary and secondary amines react with the terminal epoxide groups in curing the coating. One amine hydrogen equivalent weight of amine reacts with one epoxide equivalent weight of resin. Secondary amines so formed can then react with another epoxide group. If three or more amine hydrogens are available, a dense cross-linked polymer will be formed.

Commercial resins are normally not simple chemical compounds where "n" is a definite integer. They will usually have fractional "n" values with the molecular weight shown as a range rather than a single number. As might be expected, with increasing molecular weight the resins become increasingly harder. The simplest resins are liquid, but above the values of n=2 they are solids.

In commercial production a slight excess of epichlorohydrin is used so that the resins all terminate with

epoxide groups. This gives two epoxide groups per molecule and leads to the general practice of describing the type of resin in epoxide equivalents, which is simply the molecular weight divided by two.

Examination of the structure of the epoxy resins shows that they are polyethers having alternating aliphatic and aromatic groups. The hydroxyl radical is considered to be responsible for the polarity of the molecule, which imparts excellent adhesion.

Low Molecular Weights Used. Resins of various molecular weights can be used in conjunction with coal tar, but practical considerations dictate the use of the low molecular weight types. For example, due to viscosity build-up it is extremely difficult to incorporate a high enough percentage of the harder resins to obtain optimum chemical resistance of the mixture. Another consideration is solubility; the lower molecular weight resins will tolerate aromatic materials such as tar and coal tar solvents while the higher molecular weight resins will not, unless a ketone or other mutual solvent is used.

Lower molecular weight resins are also preferred because of their greater concentration of epoxide groups per given weight of resin. These epoxide groups are the important functional groups in room temperature conversion of the resin.

Conversion of Epoxy Resins. Most compounds having an active hydrogen atom can be used as curing agents. Many classifications have been devised and published; but for this analysis they can be divided into two main groups:

- Room temperature curing agents
- Baking or high temperature curing agents

Originally, in the tar-epoxy work, only the room temperature curing agents were considered; but since present practice sometimes includes the application of heat to pipe sections prior to aplication of the coating, some of the baking catalysts or curing agents should be mentioned.

Up to now the term "curing agent" has been used instead of "catalyst" because most of the room temperature curing agents for the epoxy resins are not true catalysts. However, the terms "catalyst," "curing agent," "hardener" and "converter" are all used interchangeably by formulators and applicators alike with no apparent confusion.

Amines Used for Air Dry Curing. Polyfunctional primary and secondary amines which react with the terminal epoxide groups of the resin are the fastest room temperature curing agents. They are used in stoichiometric amounts, i.e., one amine hydrogen equivalent weight of amine per one epoxide equivalent weight of resin, and become an integral part of the resin. The actual mechanism is illustrated in Figure 2.

The secondary amine so formed can then react with another epoxide group. If three or more amine hydrogens are available, a dense cross-linked polymer will be formed. Tertiary amines formed in these reactions can also react without an available hydrogen atom through essentially an ionic reaction. In this case they can then be considered as true catalysts in promoting the self-polymerization of the resin.

Temperature Influences Reaction Rate. The rate of these reactions is greatly influenced by heat. Practical application of the effect of heat can be utilized by lowering the temperature of the mix to prolong pot life or by heating the coated surface to reduce cure time. Very little reaction occurs below 40° F. with most commercial amines which, in fact, probably accounts for some of the difficulties encountered with wintertime use of the epoxy coatings.

Some of the well-known and often used room temperature curing agents and the amounts recommended per 100 parts of a resin of approximately 500 molecular weight are given in Table 1.

High Temperature Curing Agents. The high temperature curing agents are normally used in baking finishes, and often both epoxide and hydroxyl radicals in the resin enter into the reaction. Many of these when mixed with the resin show good room temperature stability, thereby permitting a one-package system. Some of them act as true catalysts in promoting self-polymerization of the resin, making it

TABLE 1
Room Temperature Curing Agents

Amine	Parts by Weight, PHR
1. Primary and Secondary Amines	
Ethylene Diamine	6.0
Diethylene Triamine	8.0
Triethylene Tetramine	9.5
Tetraethylene Pentamine	10.5
2. Adducts	
Modified Aliphatic Amines	20–25
3. Tertiary Amines	
Trimethylaminomethylphenol	5–15
Triethylamine	12–15
4. Miscellaneous Agents	
Polyamids	25–100
Polysulfides with amines	25–100

TABLE 2—High Temperature Curing Agents

Material	Amount, PHR
Methylene Dianiline	20-25 at 150° C.
Metaphenylene Diamine	10-15 at 150° C.
Piperidine	4-10 at 150° C.
Pyridine	17-22
Diethylaminopropylamine	8-12 at 150° C.
Phthalic Anhydride	30-60 at 150° C.
Urea-formaldehyde	15-40 at 200° C.
Phenol-formaldehyde	15-40 at 200° C.
Resorcinol	10 at 150° C.

About the Authors

Shideler

Whittier

N. T. Shideler, technical advisor in the Protective Coating division of Pittsburgh Coke and Chemical Co., is also president of Insul-Mastic division. He joined the company in 1948, starting their production of coal tar coatings. Another article by Author Shideler, "New Machine for Thin Film Coating" appeared in the March, 1958, issue of PIPE LINE INDUSTRY.

Fred Whittier has directed and supervised the research and development on coal tar coatings for Pittsburgh Coke and Chemical Company since 1952. He originally did research. Whittier graduated from Bowdoin College in 1933 and from 1935 to 1946 was employed by the Barrett Division of Allied Chemical and Dye Corporation. He served there in several capacities—research chemist, technical representative on protective coatings and chief plant chemist. Just prior to joining the Research and Development section of the Protective Coatings division of Pittsburgh Coke and Chemical Co., he was employed by the United States Testing Laboratories.

more difficult to calculate the amount needed for complete cure. Table 2 gives some of the high temperature curing agents.

The behavior of many of these curing agents in tar-epoxy systems does not follow theoretical considerations. Many cured films show serious shortcomings, such as poor underwater resistance or poor adhesion. Others have shown unexpectedly good results. Many of these discrepancies can be attributed to the tar medium in which the resin is buried. Undoubtedly, coal tar has small amounts of many functional groups containing active hydrogen such as the tar bases, mercaptans and high boiling organic acids and anhydrides.

While these groups may not be very active in promoting conversion of the resin, they probably serve as minor cross-linking agents, tying the pitch and resin components together to form a cohesive, integral coating film.

Composition of Coal Tar-Epoxies. Combining coal tars and epoxy resins to form a homogeneous coating is difficult because all work is done by empirical methods. It was not until 1953 that preliminary test coatings were made available to outside laboratories for further testing. During the work, it was necessary to screen various combinations of raw materials, coating compositions, and catalysts to obtain maximum adhesion under all conditions and to gain chemical and physical resistance, as well as most of the desired characteristics for pipe line protection. Results of more than six years of both experimental and field testing of the multitude of combinations has resulted in the production of coatings of approximately the composition given in Table 3.

Coatings of this type have been used as an industrial coating and to a limited extent in underground service since 1953. No basic changes have been made in the original coal tar-epoxy coating, except minor modifications to improve desirable characteristics such as increased adhesion under continuous immersion, elimination of "curtaining" when applied to vertical surfaces, elimination of brittleness on long exposure and improvement in chemical resistance.

Blending and Curing Characteristics. The present products are viscous, thixotropic coatings that at first appear too heavy for mixing; however, stirring, preferably with a mechanical agitator, makes the product fluid and permits incorporation of the catalyst without difficulty. Specially prepared catalysts are supplied and easily mixed into the coating. The catalytic action is exothermic and heat sensitive. Consequently, the pot life of the coating after addition of the catalyst is affected by the ambient temperature at the time of mixing and by the dissipation of heat by stirring. Tables 4 and 5 give a generalization of the normal pot life and setting time at various atmospheric temperatures. Assuming, of course, that the coating is stirred sufficiently to dissipate the heat of reaction.

Two Types Used for Pipe Lines. For pipe line work, the coal tar-epoxy coatings presently being supplied have taken two forms. One group of coatings are those in which the coal tar or coal tar pitch, epoxy resins, solvents and mineral fillers are blended and packaged in one container as the main body of the coating. Catalyst is occasionally reduced with solvent to give greater volume and is packaged separately. This formulation may be shipped in 5-gallon quantities, coating component 4.75 gallon in a 5-gallon container and catalyst ¼ gallon packaged separately. The general composition is given in Table 3.

Second type being supplied is shipped in two equal packages. One package contains the coal tar base, mineral filler, and catalyst. The second container contains the resins and solvent if used.

Special Equipment Needed for Application. Coal tar-epoxy coating systems have made it necessary to develop completely new methods of application. The product has such high internal cohesive attraction that normal pressure pot or barrel pump and atomizing pressures are not sufficiently high to give complete dispersion of the coating by spraying. Application may be by brush or roller, but to spray may require some thinning or the use of very high pressure barrel pumps, and high atomizing pressure. Fair results on application of the coating to pipe by spray have been obtained. However, new developments for the rapid application of the coating by stationary machines is in progress and test applications are being made. It is hoped that within a year equipment will be available for mill and yard application of the coating as is now common with the hot applied coatings.

The coal tar-epoxy coatings must be applied to clean bare metal, free of rust, scale, dirt and grease. If they are applied over rust and scale, their adhesion is such that they pull the rust and scale from the metal. Because of this excellent adhesion and their solvent action, they cannot be applied over other coatings.

At present, after application the setting or hardening of the coating sufficiently to permit handling of the coated pipe without damage to the coating, may be anything from a few minutes up to a few hours depending upon the temperature of the pipe and the atmosphere when using a specific catalyst. The coating may set sufficiently hard for handling of the pipe long before polymerization is complete. Ultimate chemical and physical resistance is not attained for possibly 72 hours or even a week. In most cases, the coating is sufficiently polymerized 72 hours after application for continuous immersion in water or other aqueous media.

TABLE 3
Typical Formula: Coal Tar-Epoxy Coating

Coating Component	
Epoxy Resin	30%
Coal Tar	25%
Solvent	20%
Pigment	25%
Curing Component	
Selected poly-functional amine.	

TABLE 4—Approximate Pot Life of the Mixed Coating in the Container

Temperature of Coating in Container	Approximate Pot Life Hours
40– 60° F.	6–8
60– 80	4–6
80–100	1–2
100–120	½–1

TABLE 5—Approximate Set-Up Time of Applied Coating

	Approximate Set-Up Time —Hours	
Temperature of Coated Surface	Inside Exposure	Outside Exposure
40– 60° F.	36	48
60– 80	24	8
80–100	8	4
100–120	4	2
120–140	2	1

ACKNOWLEDGMENT

This is Part 1 of a paper presented at the National Association of Corrosion Engineers annual conference, San Francisco, March 17-21, 1958. Part 2 will be presented in a coming issue of PIPE LINE INDUSTRY.

What It Takes to Be a Leader

Here is a straightforward message for every engineer who hopes to make the management team.

By Major B. Foster
Alexander Hamilton Institute, New York City

TODAY, MANY companies, faced with the generally increasing average age and approaching retirement of executive personnel, are screening their technically trained people for men who can soon be called upon to assume managerial responsibility.

Many ambitious young men ask, "What kind of an executive does an engineer make?" The question defies an easy answer because there are so many factors which have a bearing on the success of the engineer who goes into management.

We are now going through an almost unprecedented period of change. Automation in the plant, electronic computations, growth and diversification, new products of inventive genius and on the horizon the tremendous potential of peacetime atomic power have all produced technological change of a nature inconceivable a few short decades ago. The engineer has played a major part in this development, and his efforts thus far have not gone entirely unrewarded.

Indeed, for the new engineer, this is the golden age, as starting salaries shoot skyward as a result of the inexorable forces of supply and demand. Trained recruiters comb the college campuses for promising young engineers. Polite raiding is engaged in as firms try to lure engineers into their folds. Full page ads exhort engineers to seek opportunity at such and such a company where working and living conditions are described as a veritable paradise.

But not all engineers are happy with their lot. The gap between starting salaries and those paid men with ten years service is rapidly narrowing. True, good engineers can usually improve their lot by responding to the siren call of other companies, but selling a home, moving expenses, breaking friendships and uprooting the family, often deter engineers from taking this course to more money.

There is another route to more money, however, and happily it is one which is satisfying to both engineer and company alike. This route leads into management. It is no easy road but the rewards are great for those willing and able to follow it.

Engineers can make excellent executives. In fact, engineers are needed in management. But, what kind of an executive an engineer will make depends upon what he does to make himself management material.

More Engineers in Management. The influence engineers exert in management councils is continually rising. One major company reports that 25 years ago only one of their top management personnel was trained in engineering. Today this same company reports that 60 percent of its top executives came from the ranks of engineers. This trend is growing and will continue to grow so long as the engineer continues to make a successful transition into management.

If the engineer fails to broaden his outlook, to become well rounded in his thinking, he will fail; and his management will fail. It is not only industry's solemn responsibility to see to it that he does not fail, but it is his own obligation to prepare himself for future responsibility.

No one can "order" a man to be successful. No one can create a manager out of an engineer who is unwilling to learn. The engineer who goes into management must have the desire to learn and the willingness to pay the price of success.

Where Engineers Fail. Many engineers have become managers, and many of these have been failures. Some of the very traits which make a man a good engineer militate against his success as an executive. For example, engineers by training are prone to place greatest values on things that can be quantitatively measured. They take an analytical approach to their problems which does not give sufficient weight to certain things that cannot be measured. They neglect things which cannot be solved by logic alone.

But, the very core of business relationships depends upon such things as emotions, human relations, attitudes, traditions, prejudices and the like. In dealing with these things that cannot be measured the engineer is frequently unprepared.

John L. McCaffrey, Chairman of the Board of International Harvester Co. once said:

"The world of the specialist is a narrow one, and it tends to produce narrow human beings. The specialist usually does not see over-all effects on the business. And so he tends to judge good and evil, right and wrong, by the sole standard of his own specialty . . . This narrowness of view, this judgment of all events by the peculiar standards of his own pe-

Test Your Management Abilities

Are you preparing to go into management? Check this list to see if the groundwork has been properly laid. Too many negative answers may mean you should take steps to correct deficiencies.

1. **Does your interest in business go beyond purely engineering matters?**
2. **Do you seek additional responsibility?**
3. **Do you participate actively in conferences and meetings?**
4. **Are you currently studying business subjects either formally or informally?**
5. **Are you well organized?**
6. **Do you get along well with the people you work with?**
7. **Can you make decisions quickly?**
8. **Have you a real interest in your company's growth and development?**

cialty, is the curse of the specialist from the standpoint of top management consideration for advancement. Except in unusual cases, it tends to put a road block ahead of him after he reaches a certain level."

Needed: Human Relations-Reminded Engineers. The management level demands of a man the ability to work as a member of a team. The engineer who goes into management can no longer withdraw into his cocoon and study the problem at hand as if it were in a vacuum. He can no longer be a "loner" as his classroom and early job training has often taught him to be. He cannot study his problem with the time consuming thoroughness to which he is accustomed, because management demands decisions, and the manager must balance the importance of accuracy of decision against the penalties for indecision and delay.

In this big complicated world of business the engineer has much to learn. As a manager he will no longer deal mainly with other engineers. His duties will bring him in contact with accountants and buyers, salesmen and credit men, officers and clerks. A whole new and strange world of business terms and language will confront him. He'll have to gain confidences and be understanding, learn and instruct, be sympathetic, paternal or commanding as circumstances require —and all in the midst of a business organization about which his knowledge is narrowly limited.

Preparing the engineer to go into management is one of the most challenging and important jobs confronting industry today. However, the individual engineer must not take the attitude that he can stand still and wait for the company to do what is best for him. Every company expects qualified individuals who are anxious to make substantial progress to take some steps to help themselves.

What the Engineer Can Do. Companies often make available to their people various books and business literature. They frequently arrange to have visiting authorities on certain phases of business conduct seminars or workshops within the company. Many companies have an educational plan whereby the individual can be reimbursed for all or part of the costs of courses which he takes to make him a more effective employe.

But, make no mistake about it, the top rewards go to those men who take the initiative in their own development.

What can and should the engineer do to prepare himself for management? First, he must reorient his thinking. He should think of himself as a manager with engineering training rather than as an engineer in a management job. This reorientation of thinking cannot be accomplished overnight but it must be done since other steps in management development will fail unless the groundwork has been properly laid.

One way the engineer can help change his thinking from that of the engineer to that of manager is to broaden his interests. He should welcome contacts with people outside his own department, talk to salesmen, buyers, accountants and other people —listen to their problems — try to understand them. He should read business literature as well as matter on his own specialty. At home he should throw in some cultural material. Above all he should take a real interest in human relations—get to know the people he works with and listen to their very human problems.

Another thing the engineer should do is to accept responsibility eagerly. In fact, he should seek it out because many companies believe that their leaders come from men who take risks and are willing to make sacrifices. Responsibility carries risks and men who are reluctant to "stick their necks out" are usually not thought of as leaders.

Engineers going into management should have their say in meetings, being willing to take the chance of being found wrong. They should be willing to state their positions on a subject and support their positions when they are challenged.

While no value comes from stubborn adherence to a belief already proved wrong by experience, management does not want in its ranks the "yes men" so common in our fictional literature. It asks only that a man carry out loyally the decision that is finally reached.

Fundamentals, Decisions and Goals. The engineer preparing for management should organize his knowledge of business. Even the engineer, if he were asked to make a written inventory of his business knowledge, would probably leave out about half of what he does know simply because his knowledge is not organized. Studying business fundamentals will, at the very least, enable the engineer to find out what he does know and enable him better to apply that knowledge to his business problems.

Engineers must learn the art of making decisions quickly without prolonged investigation into every aspect of the question. In management, an immediate decision is frequently of more value than one painstakingly reached after several weeks of consideration. Of course, the ability to make prompt decisions is directly related to confidence, which, in turn, is based upon knowledge and experience. A fundamental knowledge of all phases of business operation is essential to successful executive decision making.

Another qualification for engineers who want to become managers is that they must identify themselves with the aims and goals of their organizations. If a management man does not derive a great deal of satisfaction from his company's growth and development, he can never be a successful manager. Ambition to forge ahead personally in business must be tempered by a real desire to promote the best interests of the organization.

The Time To Start Is Now. In management, it is never too late to learn. The personnel manager of one of our largest companies recently told me that his company had enrolled a 64-year-old manager in a management development course despite the fact he was due to retire in eight months. If companies believe further education is valuable at any stage of a man's life, certainly the individual should, since he is the one who stands to benefit most.

The above recommendations for engineers who are preparing to go into management do not cover the entire field. But they can serve as guideposts to success in management. This year many thousands of engineers will begin the transition into managers. In future years, there is no doubt that an increasing number of top management people will be drawn from the engineering ranks. —**The End**

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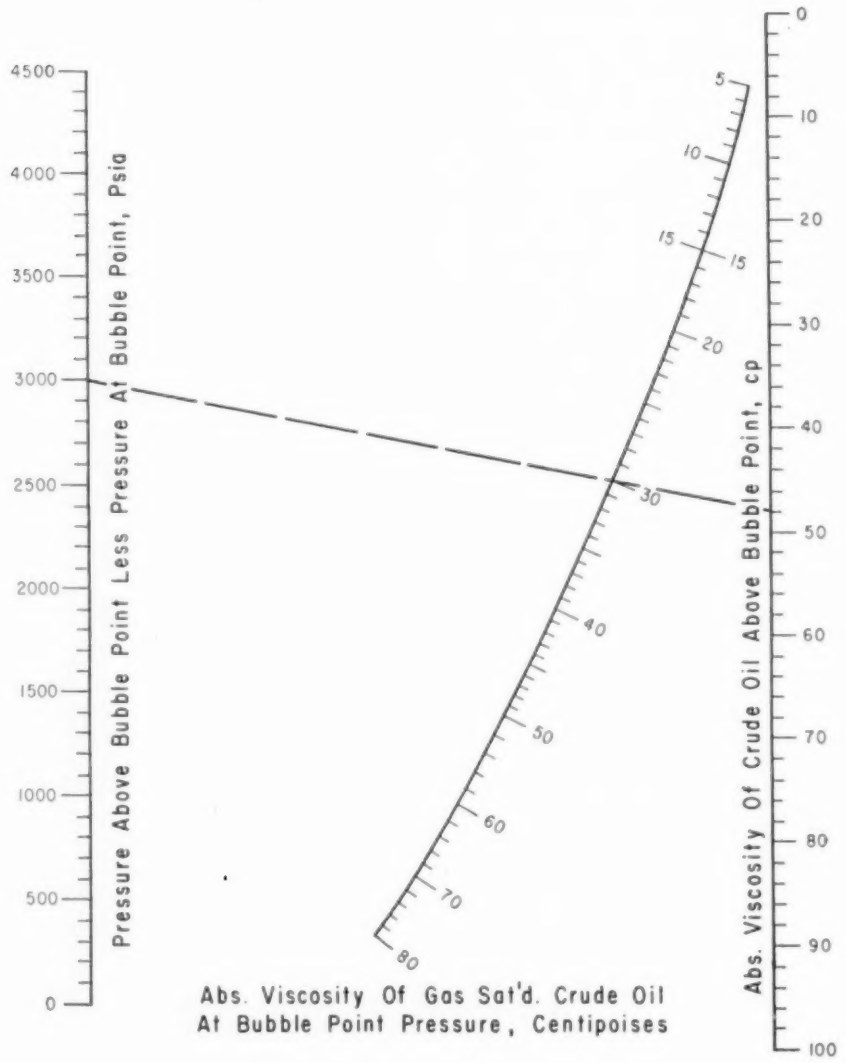
Engineering Design —45—Determining the Viscosity of Crude

If the viscosity of a gas-saturated crude oil at the saturation (bubble-point) pressure is known, using this nomograph you can quickly estimate the viscosities at higher pressures.

For Example: Find the viscosity at 4200 psia for a crude oil when its viscosity is 30 cp at the saturation pressure of 1200 psia. Notice that 4200 psia is 3000 psi above the saturation pressure. Connecting 3000 on the pressure difference scale (left) with 30 on the curved scale for viscosity at the bubble-point pressure. The intersection with the scale on the right at 48 cp is the desired value.

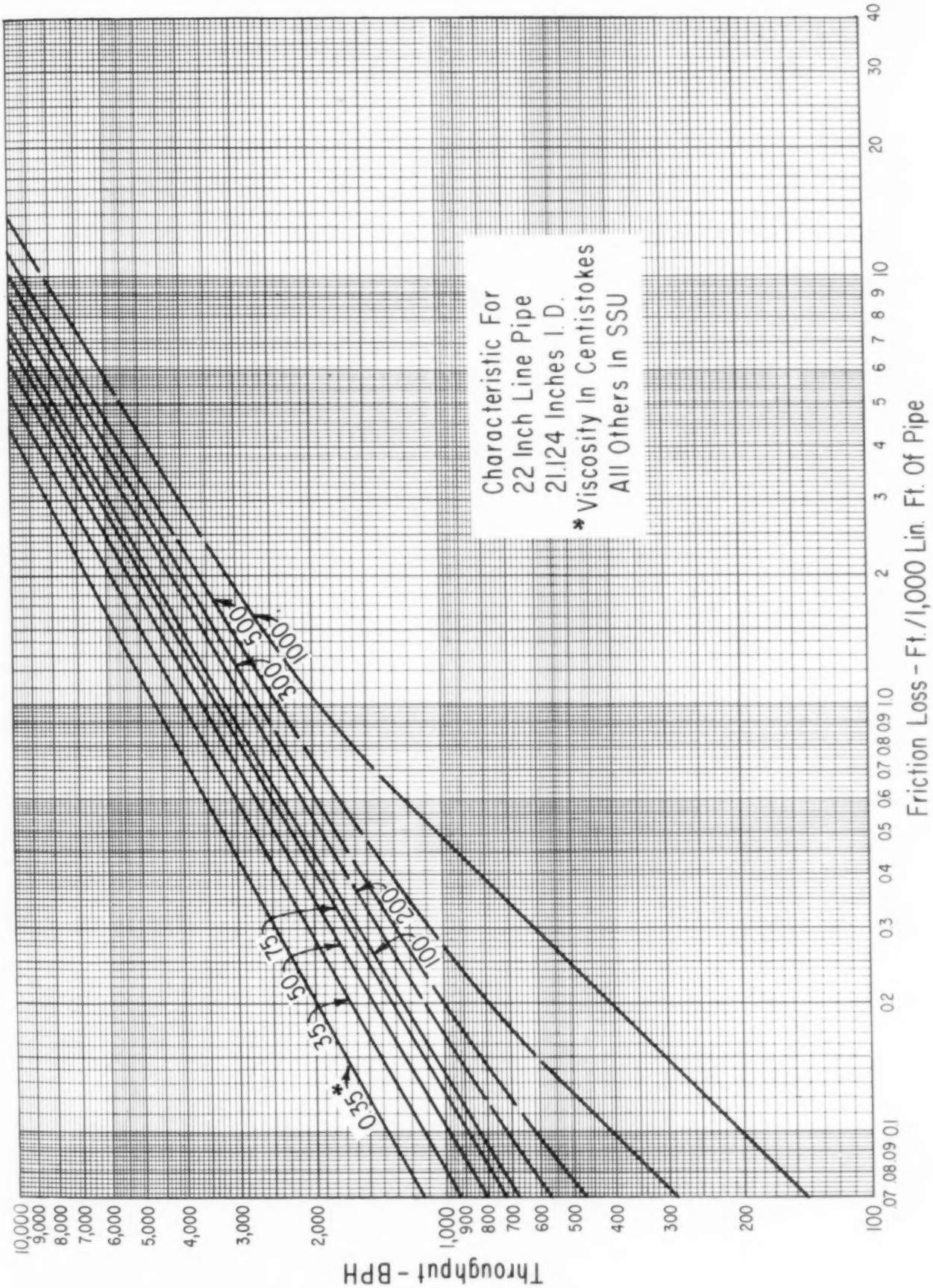


Engineering Design —46—Head Loss Charts for Various Sizes of Pipe

Friction Loss Charactistics for 22-inch pipe were computed by a pipe line company using data of the Hydraulic Institute. Use of these data in laminar and critical zones is adequate for estimates. Friction losses in transition and complete turbulent zones are very accurate.

(Chart 10 in a series of 19—22-inch line pipe)

ENGINEERING DESIGN 46



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run than other makes we've owned"

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stress of pumping!"

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How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas

Conduit Protects Ditch From Filling With Water

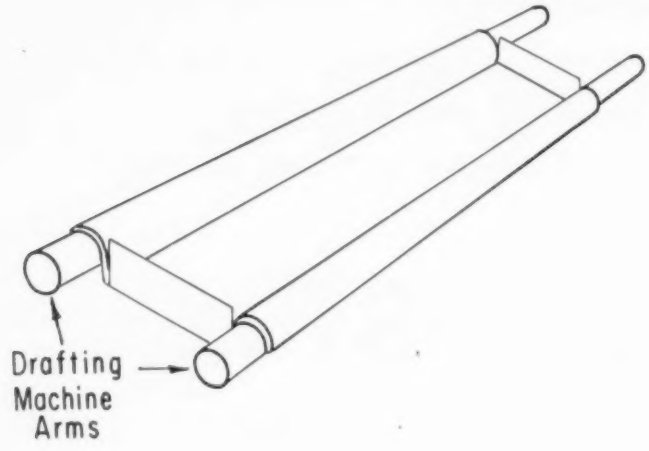
A few joints of casing can be used to prevent surface water filling up a ditch or gully while laying pipe. Used as a conduit to pass water over the gully, a pipe is extended across the ditch and sand bags are used to prevent it from washing away.

As the ditching machine approaches, the creek is dammed by hand, and a path is made for the machine. While the ditcher is passing, the downstream side of the conduit is prepared, and when the ditcher has passed, the pipe is quickly laid in place, allowing water to run through the pipe—keeping the ditch dry. The pipe is removed temporarily when the pipe gang comes along, then is replaced when the backfilling crew comes through. Conduit and sand bags are then carried ahead to the next place where the ditch is apt to fill with water.

Sliding Pump House Provides Adequate Protection for Unit

When the pipe line gager must pump his own oil, a small pump house is needed to protect the unit. One gager designed his house with one end constructed separately from the rest of the building. This enables the gager to slide the house to one side of the platform making the unit accessible from both ends. When weather is good, the pumping unit is allowed to remain open, when bad weather occurs, the house can be slid together to protect the engine.

The house is constructed with an extra two-by-four placed on the bottom of the sides. This allows the building to slide on the foundation. One end of the house is covered with sheet metal; the other is attached to the stationary foundation and makes a tight fit when the building is closed.



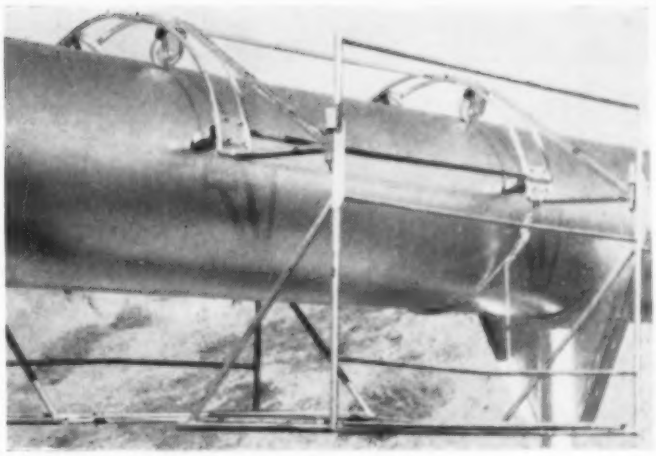
Piece of Light-Gage Metal Used to Make Pencil Tray

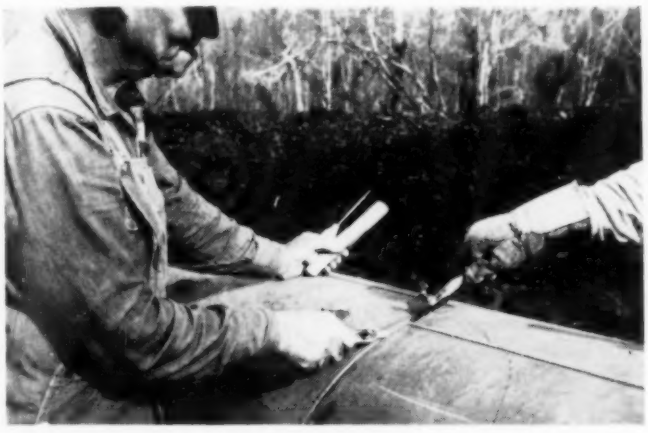
A simple tray to hold pencils and other necessary equipment for a draftsman can be made from a single piece of light-gage metal to fit certain types of drafting machines.

Width must match the machine arms; length can be made to suit requirements; depth should be made about ½ inch.

Rolling Platform Helpful For Painting Open Pipe Spans

Here is a way to avoid accidents and save money whenever you have to paint open pipe spans. A rolling platform with a locking device, which allows two men to work on either side of the pipe, is made out of small pipe and scrap steel. The rollers are casters from either baggage trucks or chairs, which are readily available. The frame can be constructed to fit any size pipe and is a dependable aid in repairing the line or the supports.





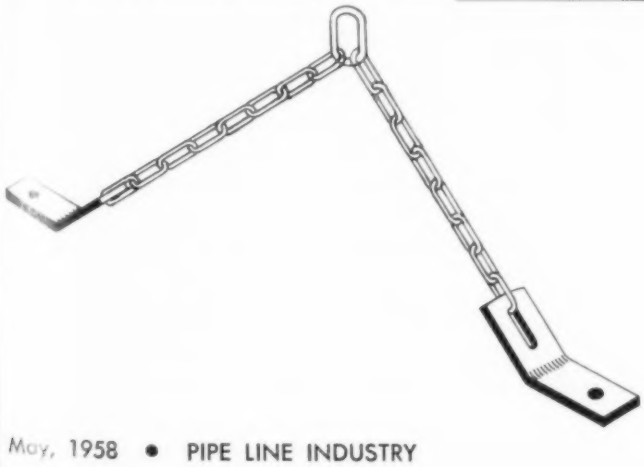
Hack Saw Blade Used to Make Knife for Cleaning Welds

A hack saw blade can be converted into a small knife which will be useful in cleaning up welds between passes. First a ⅜-inch pipe nipple is headed and flattened and the blade is placed in the front end. Then a nut is brazed over a hole in the side so that a set screw can be turned down to hold the blade in place. As the blade is sharpened and becomes worn, the remainder can be fed out by loosening the screw and slipping the blade farther out.

Business Coupe Serves As Small Storage Cabinet

The back of a business coupe auto can be made into a storage cabinet to keep necessary equipment and fixtures used in maintenance work in the field handy. The built-in cabinet is made out of 1-inch wood, which is bolted into the car. Five quart oil cans are placed on the floor and used to hold bolts, washers, pipe fittings and clamps.

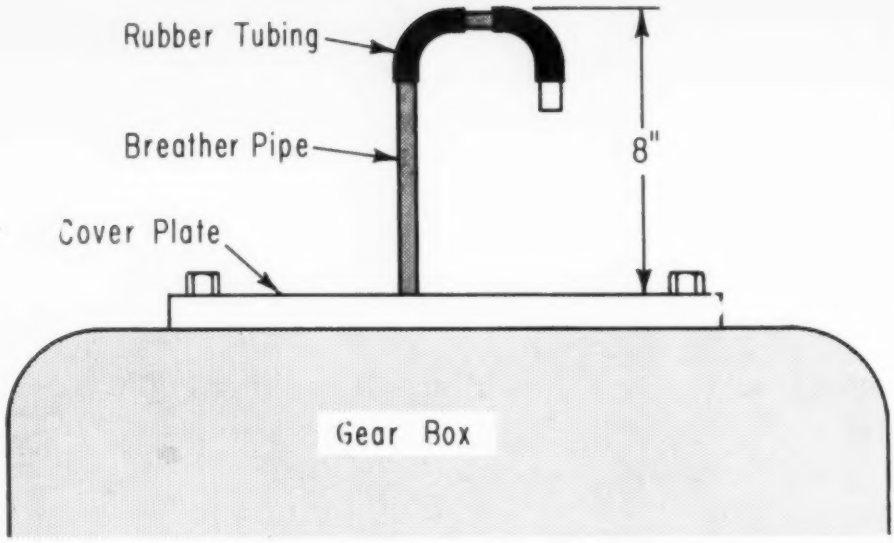
A 1-inch board is tacked on the rear window ledge and supplies are stored on this shelf. Books, raincoat and hat are placed in the center compartment on the floor. Two of the four magnetos on the middle shelf can be seen in the picture. A tool chest and small four-drawer steel cabinet are also stationed on this shelf. Tools can be reached through the window without opening the door. This is handy, especially when hands are dirty.



Handy Tool for Lifting Heads and Small Engines

Here is an easily made tool to help you in removing heads from engines or for lifting small engines themselves. The tool consists of three parts; a heavy chain, an "O" ring and some flat stock with bolt holes drilled in it.

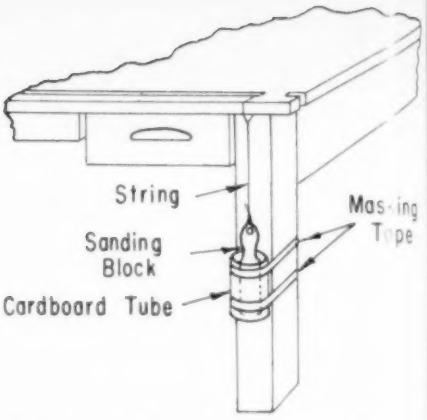
The tool is fastened to the head or engine with bolts and providing good insurance against dropping the equipment.



Gear Box Breather Keeps Water from Lube

Pump reduction gear boxes have breathers on top. When these boxes are exposed to the atmosphere, water often enters the box through the breather and contaminates the lubricant. This, of course, necessitates an excessive number of oil changes.

By installing a simple, piping breather system in the form of a "U", on the gear boxes, water is eliminated as a lubricant contaminant and the lubrication requirement on these pumps can be reduced by as much as one third.



Prevent Graphite Smudges By Using Cardboard Tube

A sandpaper block or file used for sharpening pencils is a potential source of smudges. To keep such a pencil pointer handy and prevent smudging, suspend the sanding block by a string from the edge of the drafting table so it hangs inside a section of cardboard mailing tube. The tube is fastened to the table leg with masking tape.

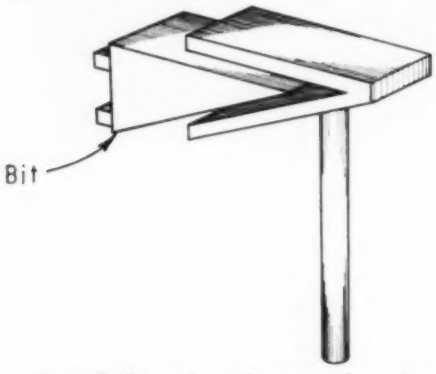
Use Turnbuckle and Valve Wheel to Make Chain Hoist

If you don't have a chain hoist or block and tackle on hand for lifting heavy objects around the shop, a turn buckle and valve wheel can be used for the same jobs.

Just weld the hub of a valve wheel to one end of the yoke of a turn buckle of sufficient size and strength to handle the loads to be hoisted. Well oiled threads on the buckle make it work easily.

Tool Removes and Installs Bits Without Damaging Edge

It is a general practice to use a hammer for driving off old worn bits and for driving on new ones on hole digger augers, clam shells, dozer blades, etc. Striking the edge directly with a hammer dulls and damges the edge. There also exists a hazard from flying splinters of steel.



A tool shaped to fit over the edge of the bit will overcome these hazards. It is held in position with a wooden handle and is struck by a hammer. If additional strength is desired the tool can be made in the shape of a socket. This will also reduce the chances of it slipping off the bit when struck.

Mount Boom on Dozer Blade To Aid in Line-up of Pipe

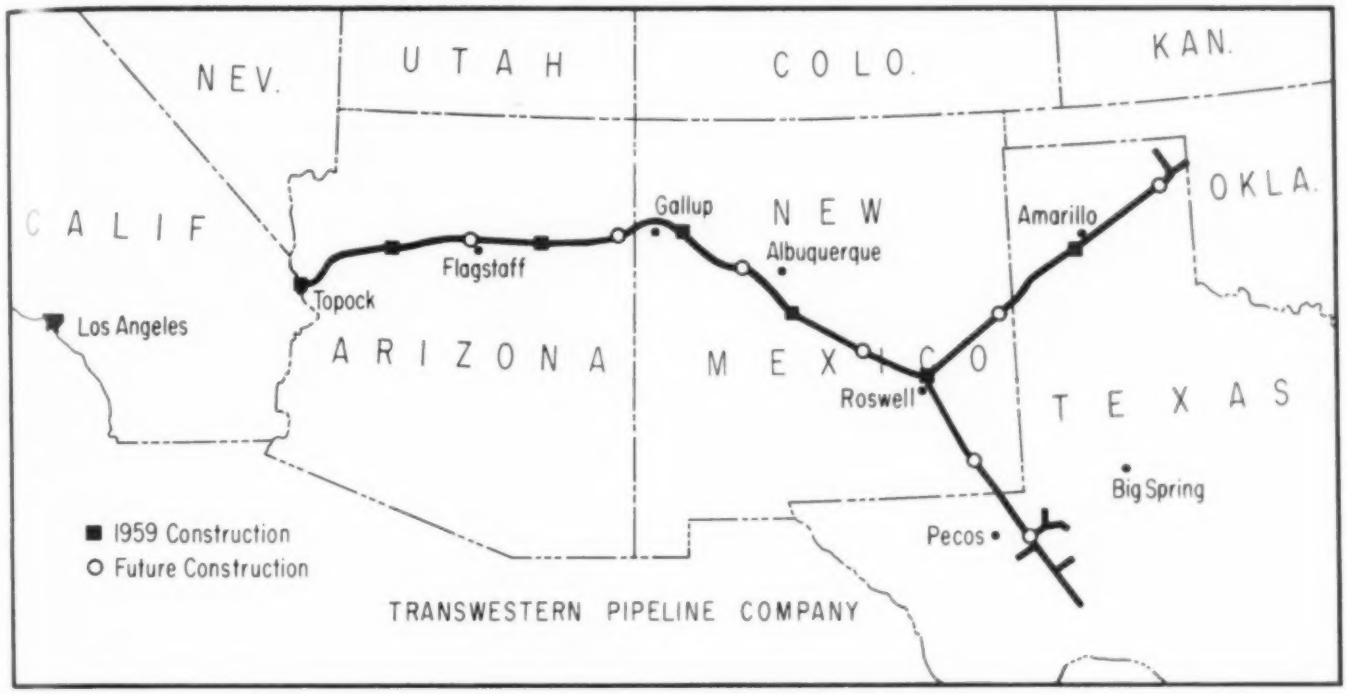
Mounting a boom on bulldozer blade will aid in line-up of pipe during weldings.

A simple hook can be used in the end of the pipe to support the joint being welded. Having the boom on the front of the tractor will give greater flexibility while handling the pipe. The entire weight of the tractor will serve as a counter weight with this arrangement. Using this design a dozer can also do the work of a side boom tractor.

WHAT'S HAPPENING

IN PIPE LINE CONSTRUCTION

By **Donald G. DePugh,** PIPE LINE INDUSTRY Staff



Transwestern Pipeline Company Files Application With FPC Requesting Authorization to Construct 1,305-Mile Gas Line

Transwestern Pipeline Company has filed an application with the Federal Power Commission requesting authorization to construct a 1,305-mile natural gas line extending from West Texas and the Oklahoma-Texas Panhandle area to the California-Arizona border.

The $193 million project will enable Transwestern to deliver 350 MMcf of gas daily to a terminal on the Colorado River at Topock, Ariz. The company's sole customer will be Pacific Lighting Gas Supply Company, which recently signed a 20-year agreement to receive gas from Transwestern. First deliveries to Pacific Lighting are scheduled to begin November, 1959. Pacific Lighting will construct a 128-mile, 34-inch line to connect Topock with the Los Angeles area. The line will cost approximately $ million and have a capacity of more than 400 MMcf/d.

The 670 miles of main line, from Roswell, N. M., to Topock, will utilize 30-inch pipe that can withstand higher operating pressures than any of the present gas transmission lines," said President John McMillian.

The lateral lines originating from Texas and Oklahoma gas fields, which will consist of 24-inch pipe, will converge at Roswell.

Transwestern plans call for an increase in compressor horsepower from its initial installation of 52,000 to 125,000 hp to accommodate a future demand for 640 MMcf of gas daily.

Construction plans call for six automatically-operated, engine-driven centrifugal compressor stations to receive gas at 725 psi and boost it to 1,000 psi. An additional eight compressor stations would be constructed after completion of the line.

Initial stations will be erected at a point near Amarillo; Roswell; Scholle, N. M.; east of Gallup, N. M.; north of Winslow, Ariz.; and Seligman, Ariz.

In addition to the 1,300-mile line, Transwestern will build a 180 MMcf per day CO_2 removal plant for the Puckett area in Pecos County. The $8.5 million plant will operate at 1,000 psi and will provide for 120 MMcf of clean pipe line gas daily.

Gulf Interstate Engineering has the contract to design and supervise the construction of the Transwestern line. Gulf Interstate will be assisted by DeGolyer and McNaughton, serving as gas reserve engineers for the Transwestern system. Arthur Anderson and Company is projecting financial economic studies and Vinson, Elkins, Weems and Searls of Houston are legal advisors.

Transwestern has also contracted for gas in the Aneth field of Paradox Basin and in the San Juan Basin and plans to construct a lateral running north from Gallup to the Four Corners area. The route and size of this line will be determined when additional reserves have been committed.

Early FPC certification would permit construction schedules to begin before 1959. It is anticipated that gas deliveries will begin by the middle of next year.

Southern Natural Gas Company Seeks FPC Permission For $65 Million Project

Southern Natural Gas Company has submitted an application to the Federal Power Commission seeking authority to construct the largest single expansion program in the history of the company.

The $65 million project will consist of 458 miles of 16 to 24-inch loop lines between Gwinville, Miss., and Wrens, Ga. There also will be 62 miles of 14-inch loop lines along the Atlantic-Macon line and approximately 53 miles of 6⅝ to 14-inch loops along various branch lines.

Additional compressor station facilities of 3,410 horsepower will be installed at Gallion and Elmore, Ala., and Wrens, Ga.

Southern Natural will have a delivery capacity in excess of the firm's present obligation to its customers when the looping project is completed. Greater delivery capacity will enable the gas company to provide for unusually protracted periods of severely cold weather.

Facilities in the latest application designed to attach such additional gas supplies include 60 miles of 20-inch loops along the Southern Louisiana supply system between Franklinton and White Castle and South of Toca.

Also lateral lines south of Gwinville and a loop which extends west of Gwinville to Cranfield field will be laid. The project connects seven new gas fields to Southern's lines. Bayou Felice, Coffee Bay, Triumph, Cranfield, Hub, Ship Shoals Blocks 28 and 32 are the fields from which gas will be taken.

Approximately 8,720 hp will be added at Franklinton, White Castle, Patterson, and Brookhaven stations.

Southern Natural previously had filed applications with the FPC for permission to construct pipe line facilities in southern Louisiana with expenditures exceeding $40 million. The entire 1958-59 program contemplates about 1,200 miles of pipe to gather gas from about 35 fields in southern Louisiana and the Gulf of Mexico area. The system's capacity will be increased about 300 MMcf of gas per day. Gas will be delivered to customers in Mississippi, Alabama, Georgia and South Carolina. The expanded system will also be able to supply the needs of Georgia Coastal Natural Gas Corporation, a new pipe line project which proposes to serve an area in Southeast Georgia. Brunswick and Waycross and 20 other communities will benefit from this new line.

Construction on the new facilities will start as soon as approval is received and financial arrangements are made. The project should be completed by the summer of 1959.

Michigan Wisconsin Plans To Construct Gathering System

Michigan Wisconsin Pipe Line Company recently filed an application with the Federal Power Commission seeking permission to construct a gathering system in Laverne field, Harper County, Oklahoma.

The application has been consolidated with four other applications seeking natural gas service from Michigan Wisconsin or its affiliate, American Louisiana Pipe Line Company.

Michigan Wisconsin plans a $22 million system which will include 56 miles of 20-inch line to connect the gathering system to its main line, 45 miles of 12¾ and 24-inch loop lines; 10 new main line compressor stations totaling 35,100 horsepower; and 8,150 additional hp in four existing compressor stations.

In its application Michigan Wisconsin said the proposed construction would enable it to transport about 40 MMcf of additional gas daily from the Laverne field to existing markets principally in Michigan and Wisconsin.

Other applications linked with Michigan Wisconsin's expansion program include Northern Illinois Gas Company, Michigan Gas Utilities Company and Northern Indiana Service Company. These companies have filed with the FPC requesting the commission to order Michigan Wisconsin to sell gas to them.

Contracts Let on Gulf Interstate Looping Project

Gulf Interstate Gas Company has let contracts on its 350-mile looping project in Kentucky, Louisiana, Mississippi and Tennessee.

Houston Contracting Company has been awarded the southern section which includes six loops totaling approximately 217 miles of 30-inch through Louisiana, Mississippi and Tennessee. The work will be done in two spreads; one starting in Louisiana and the other in Mississippi.

H. C. Price Co. will construct four loops in the northern portion which consist of 133 miles of 30-inch in Kentucky and Tennessee.

Gulf Interstate also has 55 miles of 24-inch loops to be constructed in southern Louisiana. Contracts will be awarded soon on this section.

Shell Plans 70-Mile Line in Venezuela

Cia Shell de Venezuela plans to construct a 70-mile heated crude line along the Eastern shore of Lake Maracaibo. With a capacity of 440,000 b/d, the line will carry crude from Bachaquero field to an $84 million terminal at Puerto Miranda.

The final 31 miles, from Cabimas to Puerto Miranda, will be built with 34-inch pipe and 30-inch pipe will be used for the section between Bachaquero and Cabimas. The 31-mile segment will be paralleled with a 31-inch line, which will not be heated.

Pump stations will be located at Bachaquero, Lagunillas, Puerto Miranda and Cabimas. Three 2,500 horsepower pumps and six 500 hp pumps, two 170,000 bbl tanks, and three 45 million-B.t.u. per hour heaters will be installed at Bachaquero. At Lagunillas, three 2,500 hp pumps, four 600-hp pumps and three heaters will be constructed. Three 2,100 and three 2,500-hp pumps plus four 750-hp pumps, eight 120,000 bbl tanks, three 170,000 bbl tanks and four heaters will be built at Cabimas.

At the Terminal del Notre in Puerto Miranda, two piers with seven loading berths, having a capacity of 500,000 b/d, 23 tanks, two heaters, nine 750-hp pumps and a 10,000 kw gas-turbine electric-power plant will be installed.

The line will carry offshore as well as onshore production and will replace some tankers now in use and some existing pipe lines.

N PL, Texas-Illinois Propose $9 Million Expansion Plan

atural Gas Pipeline Company of A rica and Texas Illinois Natural G Pipeline Company have filed ap- pl ations with the Federal Power Co mission for approval of plans to br g additional gas to their Chicago ar markets.

atural Gas Pipeline has proposed an alternative plan to its Beatrice project to supply 185 MMcf of gas daily to its markets. The proposal calls for construction of 511 miles of loop lines between the Texas Panhandle and Joliet, Ill. The section from the Panhandle to Beatrice will include 258 miles of 36-inch and 21 miles of 26-inch pipe; the remaining portion between Beatrice and Joliet will consist of 232 miles of 36-inch pipe.

If FPC authorization is granted by May 1, Natural Gas Pipeline Company will be in á position to make the additional gas available by Jan. 1, 1959.

Gas will come from reserves in Texas which were made available to Natural Gas Pipeline Company through construction of a 350-mile line extending from Jack and Wise counties to its main line near Fritch, Texas. This line, completed in December, 1957, at a cost of $29 million, is connected to reserves which include, among others, those of Lone Star Gas Company, and which will be the principal source of supply.

Texas Illinois plans to increase its daily delivery capacity from 504 MMcf to 524 MMcf with additional compressor engines at eight of its 11 existing stations. The $3.9 million expansion project will add 2,000 horsepower to stations at Lufkin and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, M and Hammond, Ill.

he expansion program of the two co panies has been made possible by ra settlements filed with the FPC. TI rate filings are expected to result in he refunding of more than $10 m on to NGPL and TI customers. T settlement, made necessary by th Memphis Decision, will clear up m y of the financial uncertainties w h have made it difficult for pipe li companies to finance expansion a bring more gas to the Midwest.

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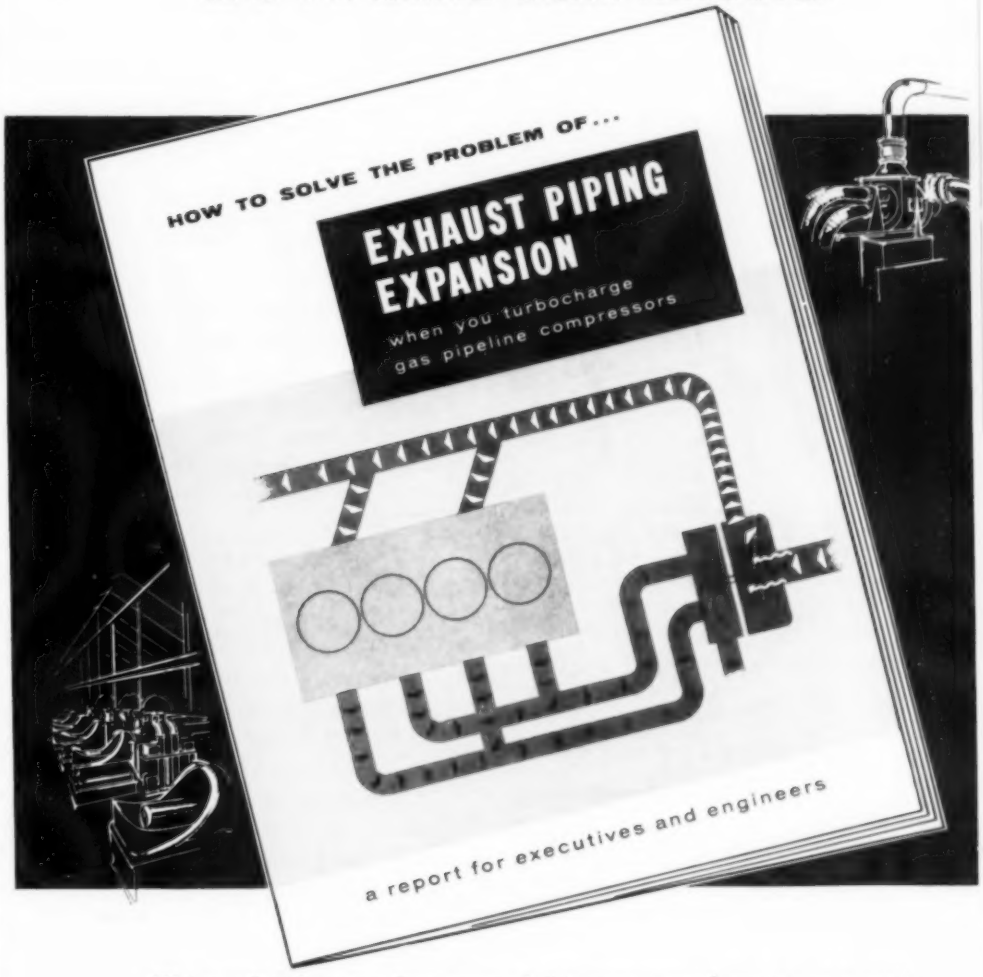
WHEN TURBOCHARGING GAS PIPELINE COMPRESSORS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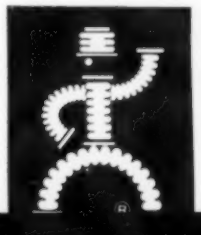

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El Paso Granted Permission to Construct $138 Million Pipe Line Expansion Project

El Paso Natural Gas Company has been granted Federal Power Commission authorization to construct pipe line facilities estimated at a cost of $138 million.

Construction of these facilities will enable El Paso to delivery an additional 185 MMcf of gas daily to customers in Arizona and California. The FPC acted on two El Paso filings, but in one it approved only the facilities necessary to enable the company to connect new sources of gas supply.

The application which was approved in its entirety includes 216 miles of trunk lines, 58,900 horsepower compressor capacity, and field facilities consisting of 533 miles of line and 27,850 compressor hp located in Arizona, Texas and New Mexico.

The field facilites which were approved in the second application consist of 266 miles of gathering line, 8,920 hp in compressor capacity, and dehydration, metering and other equipment.

The reason for the Commission's disapproval of main line facilities in the second application was cited as insufficient gas supplies.

Texas Eastern Authorized To Construct Gas Facilities

Texas Eastern Transmission Corporation has been given authorization by a Federal Power Commission examiner to construct and operate natural gas facilities estimated to cost $37.5 million.

Approval was given for construction of 59 miles of 30-inch and 22 miles of 14-inch, 147,780 additional compressor horsepower at existing compressor stations in Louisiana, Mississippi, Pennsylvania, Ohio, Kentucky and Tennessee, and a new 2,200 hp compressor station.

Texas Eastern Penn-Jersey, a subsidiary of Texas Eastern, has been authorized to add 4,000 hp to its Delmont, Penn., compressor station and to construct five new compressor stations in Pennsylvania with a total capacity of 67,000 hp. Cost of this project is approximately $11 million.

The additional facilities will be used to increase Texas Eastern's system capacity to supply an additional 101.7 MMcf of gas daily to 11 customers.

Sui Gas Transmission Company To Extend 16-Inch Gas Line

Sui Gas Transmission Company, Ltd. plans to extend its 16-inch line, running northeast from Sui, East Pakistan, 130 miles to Lyallpur, East Pakistan.

The 310-mile section of the Sui line to Multan, East Pakistan, is being completed presently. The new line will furnish fuel for central power plants which will replace the fuel-oil burning generators operating at individual mills of the cotton-weaving center.

Preliminary estimates of gas offtake in Lyallpur by the end of 1960 are about 14 MMcf daily.

Buckeye Pipe Line Company To Construct 50-Mile Line

Construction will begin soon on a 50-mile extension of the Buckeye Pipe Line Company products line in New York.

The main line construction will consist of 10-inch pipe and will extend from a point just north of Syracuse to existing shipper terminals at Utica, N. Y. Work will start in the spring and is scheduled for completion in September.

The 371-mile products system runs from refineries in New Jersey to marketing areas in Pennsylvania and New York.

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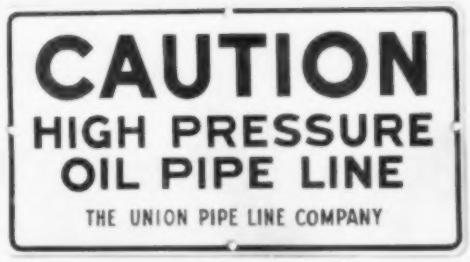

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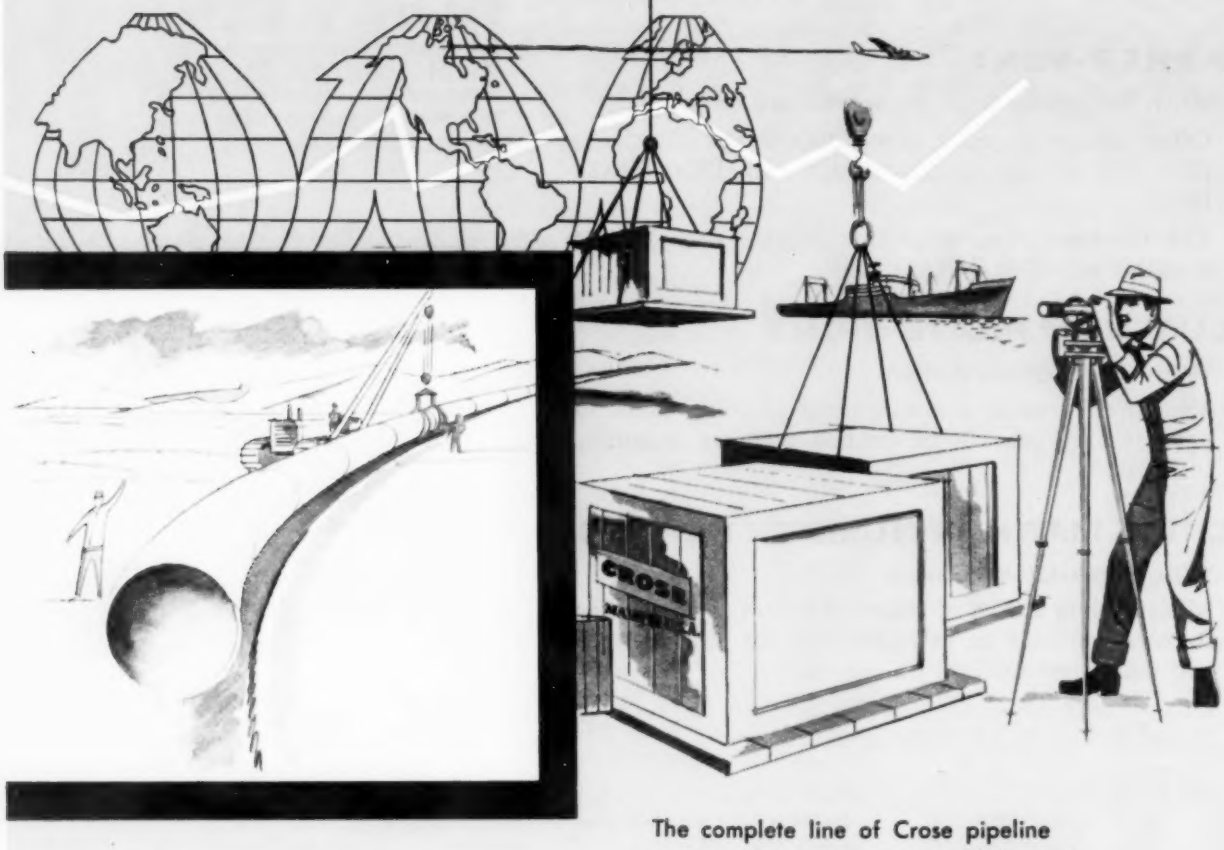

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PROPOSED PIPE LINE CONSTRUCTION

Here in convenient summary form is Pipe Line Industry's listing of company, line size, length, service, location and project status.

U. S.

Buckeye Pipe Line Company, New York. 50 miles, 10-inch, products, main line, from point north of Syracuse to Utica, N. Y., planned.

Chicago District Pipeline Company, 52 miles, 30-36 inch, gas, from Natural Gas' proposed line at Joliet to Chicago, $13 million, before FPC.

Coastal States Gas Producing Co., Corpus Christi, Texas, 45-mile, gas gathering system in Bee County, Texas to connect with Texas Eastern's main pipe line, $1 million, planned.

Coastal Transmission Corp., Houston, 574 miles, 22-24 inch, gas, from McAllen, Texas to Baton Rouge, La. connection of Houston, Texas Gas and Oil plus 414 miles of laterals, $55 million, authorized.

Colorado Interstate Gas Co., Colorado Springs, 734 miles, 24-30 inch, gas, from Texas & Okla. Panhandle to Kit Carson, Colo., to Beatrice, Neb., plus four compressor stations, $87 million, before FPC.

Conn-Mass Pipe Line, Inc., Orange, Conn., 88 miles, 8 inch, products, from Boston to Springfield, Mass., considered.

133 miles, 16-inch, products, from Linden, N. J. to Hartford, Conn., considered.

62.2 miles, 8-inch, products, from New Haven, Conn. to Springfield, Mass., considered.

38 miles, 6-inch, products, from Waltham, Mass. to Fitchburg, Mass., considered.

Deep Rock Gas Co., Oklahoma City, 120 miles, 6-inch, LPG, from Tioga, N. D., to Canadian border, planned.

Eastern Shore Natural Gas Company, Salisbury, Md., 124 miles, 6 and 8-inch, gas facilities on eastern shore areas of Delaware and Maryland, $3 million, authorized.

El Paso Natural Gas Co., El Paso, 835 miles, 4½-34-inch, field and main lines, facilities in Texas, New Mexico and Arizona, $80 million, 362 miles authorized and contracts let.

511 miles, 34-inch, gas from Twin Falls, Idaho, to California boundary near Las Vegas, planned.

4½ to 20-inch, field lateral lines, gas, in Texas, New Mexico and Arizona, authorized, before FPC.

18 miles, 12-inch, gas, loop between Good Field and East Vealmoor, Texas, temporary FPC authorization.

59 miles, 20-inch, and 9 miles, gas, field lines in Crane and Pecos counties, $4 million, before FPC.

Emerald Pipe Line Corp., 120 miles, 6 inch, products, from Sunray, Texas, to Tucumcari, N. M., planned.

Equitable Gas Company, Pittsburgh, Penn., development of Rhodes natural gas storage pool in Lewis County, W. Va., and construction of 11.7 miles of storage pipe line and other facilities, $2,091,430, authorized.

Everglades Pipe Line Company, Miami, Fla., 35 miles, 10-inch, products, Port Everglades to Miami International Airport, $2.5 million, planned.

Gillette Pipeline Co., Cheyenne, Wyo., 103 miles, crude, from Dead Horse Creek field to Casper, Wyo., planned.

Great Northern Railway, St. Paul, 400-600 miles, 12-20 inch, crude, from Williston Basin to St. Paul-Minneapolis and Duluth-Superior areas, considered.

Gulf Interstate Gas Co., Houston, 12.8 miles, 6 and 20 inch, gas, loop line in Louisiana, $730,000, authorized.

350 miles, 30-inch, and 55 miles, 24-inch, loop lines in Kentucky, Mississippi, Tennessee, and Louisiana, $50 million, contracts let on 350 miles to Houston Contracting Company and H. C. Price Company.

Harry Bass & Sons, Inc., Dallas, pipe line network from well heads to compressor stations to central gasoline plant plus line to railroad in Pembina field, Alberta, $17 million, approved.

Home Gas Co., Pittsburgh, Penn., gas facilities in New York, $3.8 million, authorized.

Humble Oil & Refining Co., 250 miles, 26 or 30 inch, gas, and 200 miles, main gathering system, line of varying sizes, from southwest Texas to Houston, plus gas processing and cycling plant near Corpus Christi, $75 million, planned.

Iron Ranges Natural Gas Co., 115 miles, gas, from Itasca and St. Louis counties along route of Mesabi range from Grand Rapids to Aurora, Minn., $5 million, before FPC.

Jayhawk Pipe Line Corp., Wichita, Kansas, 242 miles, 10 and 12 inch, crude, from western Meade County to Valley Center, Kansas, $8.6 million, planned.

Katy and New York Central Railroads, 2500-mile, 10-12 inch, LPG, from Houston, Texas, to New York, considered.

Kerr-McGee Oil Industries, Inc., 24 miles, 4 inch, gas, to connect wells with its Breton Sound production island off the Louisiana coast, authorized.

Magna Pipeline Co., 40 miles, gas, underwater line from Anacortes, Wash., to Victoria, B. C., $6 million, planned.

Manufacturers Light and Heat Co., Pittsburgh, Penn., 13.8 miles, 10 and 12 inch, gas, facilities in Ohio and West Virginia, $757,300, authorized.

Michigan Gas Storage Co., Jackson, Mich., gas, facilities in central Michigan, $2 million, authorized.

40 miles, 26-inch, gas, main line, from point in Gratiot County to Isabella County; and 25 new wells in Winter field and Cranberry Lake storage fields, $4 million, FPC examiner authorization.

Michigan-Wisconsin Pipe Line Co., Detroit, 472 miles, 4- 24-inch, gas, main line loops and extensions in Wisconsin, Illinois, $17.6 million, before FPC, temporary authorization for a part, 47.5 miles let to G. E. T. Construction, Inc.

56 miles, 20-inch, gas, gathering, to connect system with main line; 45 miles, 12¾ and 24-inch; gas, loops, 10 compressor stations totaling 35,100 hp, 8,150 additional hp in existing stations, before FPC.

148 miles, 4-20 inch, gas, line to connect new gas supplies in Laverne field, Northwestern Oklahoma, planned.

Midwestern Gas Transmission Co., 350 miles, 30-inch, gas, from Portland, Tenn. to Joliet, Ill., $45 million, before FPC. Proposed portion of original project extending to Canada.

Mookl Chemical & Gas Corp., Tulsa, and **Missouri Transmission Corp.**, Springfield, Mo., 425 miles, 16-inch, gas, from Oklahoma City area to St. Louis, before FPC.

Natural Gas Pipe Line Co. of America, 416 miles, 36 inch, gas, loops at various points along existing line between Beatrice, Neb., and Joliet, Ill., $76.2 million, before FPC.

396 miles, 30-inch, gas, loops between company's terminus near Fritch, Texas and Joliet, Ill., $63 million, before FPC.

258 miles, 36-inch and 21 miles, 26-inch, gas, loops, between Fritch, Texas, and Beatrice, Neb.; 232 miles, 36-inch, loops, between Beatrice and Joliet, Ill. $87 million, before FPC.

New York State Natural Gas Corp., Pittsburgh, Penn., gas, facilities in New York state, $1.2 million, authorized.

North Carolina Natural Gas Corp., 630 miles, 2-16 inch, from Transco's system near Mooresville across to southeastern North Carolina, authorized.

Northern Natural Gas Co., Omaha, 167 miles, 20 inch, gas, from Farmington, Minn. to Duluth, Minn., and Superior, Wis., $12 million, before FPC.

42 miles, 10 inch, gas, from Rochester, Minn. to Winona and Goodview, Minn., $963,000, before FPC.

365 miles, gas, new facilities in Minn., Iowa, S. D., Neb., Wis., plus 1090 miles of branch line and station facilities, $65.7 million, authorization for a part. Gas facilities in Texas, Oklahoma and Kansas, $6 million, before FPC.

454 miles, main line loops and extensions, 6-30-inch, main line from St Cloud, Minn., to Grand Forks, N. Dak., also 1,490 miles of branch lines, 2-10-inch, and station additions totaling 32,000 horsepower, $86 million, planned.

27.6 miles, 30-inch, gas, loop; 18.3 miles north of Beaver station in Okla., 9.3 miles north of Sunray station in Texas, $3 million, authorized.

Northwest Pipeline Corp., Salt Lake City, 350 miles, 6-10 inch, crude, from Four Corners area to Salt Lake City, $15 million, considered.

Northern Utilities Co., 35 miles, 16 inch, gas, in Fremont Natrona County, Wyo., area; 8 miles, 12 inch, around Casper;

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6 miles, 8 inch, from Sand Draw gas field to Beaver Creek field; 12 miles, 6 inch, from Beaver Creek field to the system servicing the Riverton-Lander area, planned.

Ohio Fuel Gas Co., Columbus, Ohio, 56 miles, 18-24 inch, gas, Richland County, Seneca County, Sandusky County to Toledo area, $4 million, contract for 22 miles awarded to H. L. Gentry Construction Co.

33 miles, 4 to 20 inch, various counties, Ohio, $1 million, authorized.

21.8 miles, 12 and 20-inch, natural gas facilities in various counties, Ohio, $1 million, authorized.

Ohio Oil Company, Findlay, Ohio, 150 miles, 12 inch, products, from Wood River, Ill. to Chicago, 84 miles let to Panama-Williams Corp.

Pacific Gas & Electric Co., 1300 miles, gas, from Alberta, Canada to Antioch, Calif., $380 million, planned.

Pacific Lighting Gas Supply Co., 128-mile, 34-inch, gas, main line from Topock, Ariz. to Newberry, Calif., planned.

Pacific Northwest Pipeline Corp., Salt Lake City, 235 miles gas, gathering lines in San Juan Basin, Garmesa, Piceance Creek, and Big Piney Fields, $13.5 million, planned.

65 miles, gas, sales laterals in Washington, $1.5 million, planned.

52 miles, 30-inch loop Big Piney, Wyoming, gathering system, $5 million, planned.

Panhandle Eastern Pipe Line Co., Kansas City, 33 miles, 16 inch, gas, Muncie, Ind., lateral, contract let to O. R. Burden Construction Corp.

Pennsylvania Gas Co., Warren, Penn., 38 miles, 8 and 10 inch, gas, in Erie and Warren Counties, Penn., and Chautauqua County, N. Y., $2.6 million, authorized.

Permian Basin Pipeline Co., Omaha, Neb., 26.8 miles, 10 inch, gas, from a point on existing system in Pecos County, Texas, to a gasoline plant, $787,100, authorization.

Piedmont Gas Co., Hickory, N. C., 78 miles, 2-8 inch, gas, from connection with Transcontinental Gas Pipe Line to serve customers in North Carolina, $2.6 million, authorized.

Shell Pipe Line Corp., Houston, 100 miles, 18-20 inch, crude, from Shell's Southwest Pass terminal to Shell's Norco Refinery near New Orleans, $10 million, planned.

Southern Kansas Pipe Line Co., Inc., Arkansas City, Kansas, 200 miles, 6-10 inch, crude, southwestern Kansas to Arkansas City, Kansas, planned.

Southern Natural Gas Company, Birmingham, 136 miles, 24 and 26 inch; 215 miles, various diameter supply lines; 3,650 additional compressor horsepower to White Castle and Toca Stations; 8 miles, 20-inch loops; 660 hp Franklinton station, and 23 measuring stations. $40 million, before FPC.

45 miles various diameter supply laterals; 2000 hp at Toca station; 660 hp at Franklinton; and measuring facilities; $4 million, contract let to Houston Contracting Co.

458 miles, 16-24-inch, loop lines, gas, between Gwinville, Miss., and Wrens, Ga.; 62 miles, 14-inch, loops, along Atlanta-Macon line; 53 miles, 6⅝ to 14-

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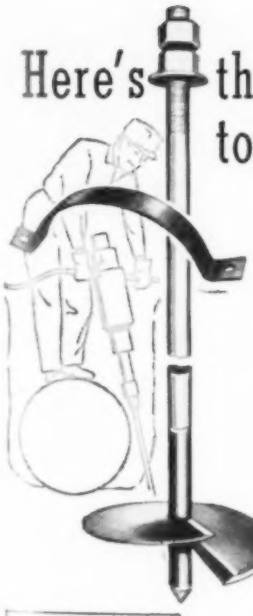

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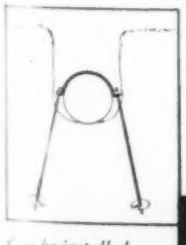

Can be installed in the ditch without extra digging.

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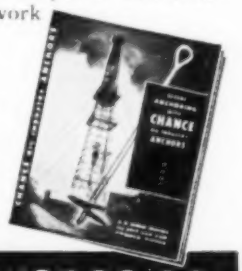

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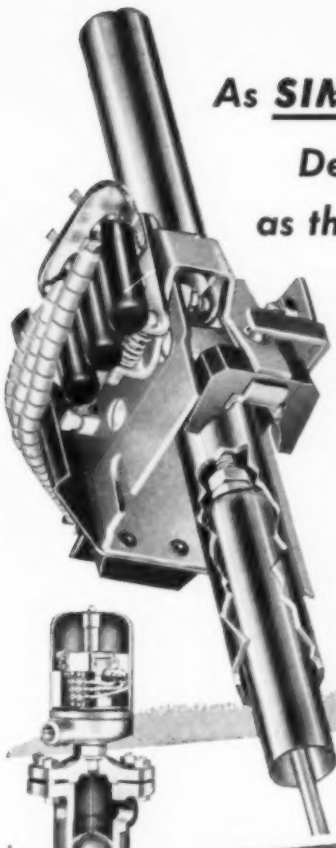

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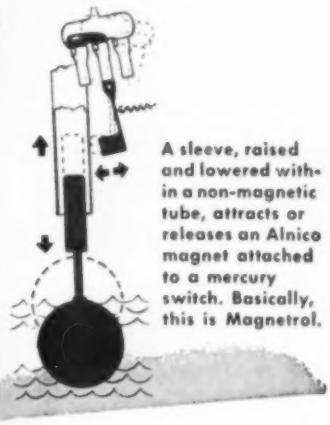

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ch, loops, along various branch lines. 140 additional hp at Gallion and Elore, Ala. and Wrens, Ga. 60 miles, 20-ch, loops, in Louisiana between Franklnton and White Castle and South of oca. Lateral lines south of Gwinville and est to Cranfield field. 8,720 hp added t Franklinton, White Castle, Patterson and Brookhaven. $65 million, before FPC.

Tennessee Gas Transmission Co., Houston, 632 miles, 24 and 30 inch, gas, from Louisiana delta to Portland, Tenn. and Coudersport, Pa. to Hamburg, N. Y., temporary FPC authorization.

264 miles loop lines in Tennessee, Kentucky, West Virginia and Pennsylvania, temporary FPC authorization.

Compressor stations in Mississippi, Tennessee, New York, Pennsylvania and additions in Tennessee, Kentucky, Ohio and Pennsylvania, $129 million, temporary FPC authorization.

Texas Eastern-Penn-Jersey Transmission Corp., Shreveport, La., 65 miles, gas, from Delmont, Penn., to Lambertville, N. J., before FPC.

24,000 compressor hp additions to existing stations, $4.4 million, temporary FPC authorization.

Texas Eastern Transmission Corp., Shreveport, La., 267 miles, 14-30 inch, gas, Louisiana, Mississippi, Pennsylvania and New Jersey, $50 million, before FPC.

59 miles, 30-inch, gas, loop additions to pipe line from Kosciusko, Miss. to Uniontown, Penn., $5.8 million, temporary FPC authorization.

96.5 miles, 30-inch, gas, between Kosciusko, Miss., and Uniontown, Penn.; 9.4 miles of supply laterals; a 10,250 hp compressor station, and 33,360 hp to existing compressor stations, $24.5 million, authorized.

Texas Eastern Transmission Corporation and Wilcox Trend Gathering System, Inc., gas, compressor stations, $4 million, authorized.

Texas Gas Gathering Corp., Shreveport, 36.6 miles, gas, gathering system in Rodney Field, Jefferson County, Miss. and from North and South Locust Ridge, Lake St. John Field in Tensas and Concordia parishes, La., $855,413, before FPC.

Texas Illinois Gas Pipeline Company, Chicago, 16,000 additional hp to stations at Lufkin, and Marshall, Texas; Texarkana, Malvern, Searcy, and Biggers, Ark.; Jackson, Mo.; and Hammond, Ill., $3.9 million, before FPC.

Transcontinental Gas Pipe Line Corp., Houston, 204 miles, 36-inch, 107 miles, 30-inch, main line loops in 10 states; intermediate stations: North Carolina, Virginia, Pennsylvania; 2,500 additional hp at six compressor stations; 164 miles, 24-inch from Leidy storage Penn.; miles, 30-inch, New Jersey; gather- lines, Louisiana, 119 miles; 10 meter tions; additions to West Cameron and ch Island area, 35-miles, 16-inch, 26 les, 10-inch, and three gathering er stations; 45 miles, 16-inch, purase laterals and 5 meter stations, uisiana; 67 miles, 10, 12, 20-inch iscellaneous transmission purchase lats in Texas and Louisiana, 3 meter tions; 51 miles, 36-inch and 1 mile, inch in New Jersey; 51 miles, 10- 14-inch and 3 meter stations, southeast Louisiana (mainly offshore), $137.3 million before FPC.

151 miles, 24-inch, 12 meter stations, southeast Louisiana, $14.5 million before FPC.

2,500 additional hp at four compressor stations, St. Francisville, La.; Laurel, Miss.; Linden, Ala. and Wadley, Ala., $3 million before FPC.

Wells, pipe lines, measuring equipment, stations at Leidy storage in Pennsylvania, $12.5 million before FPC.

Trans-Utah Pipeline, 16-inch, gas, main line from Uinta Basin to Salt Lake City, considered.

Transwestern Pipeline Company, Houston, 1,305 miles, 24- and 30-inch, gas, main line, from West Texas and Oklahoma-Texas Panhandle area to Topock, Ariz., $193 million, before FPC.

Underground Storage & Exploration, Upper Darby, Penn., 394 miles, 12-inch LPG, from Moundsville, W. Va. to Newark, N. J., $9 million, approved.

95 miles, 6-8 inch, laterals to Mauch Chunk, Penn., and to Philadelphia, planned.

United Gas Pipe Line Co., Shreveport, La., 203 miles, 30-inch, gas, between New Orleans and Mobile, Ala., $33.7 million, authorized.

International

ACT Oils, Ltd., Montreal, 400 miles, crude, Dawson Creek, B. C., to Bella Coola, B. C., before B. C. government.

Alaska-Yukon Refiners and Distributors, Ltd., Edmonton, Alta., 150 miles, products, serving Alaska and Yukon territory, $3.5 million, planned.

Bituminous Oil Pipeline Co., Calgary, 250 miles, crude, from Athabasca tar sand plant in northeastern Alberta to Edmonton, approved.

British Petroleum Co., 60 miles, crude, from deep water tanker terminal at Milford Haven, U. K. to Llandarcy Refinery, $18 million, planned.

Burmah Oil Co., Ltd., 850 miles, crude, 20 inch, from Nahorkatiya to Calcutta, India, planned.

Cia Shell de Venezuela, 70 miles, 30- and 34-inch, crude, main line, from bachaquero field to Puerto Miranda; 31 miles 30-inch, Bachaquero to Cabinas; four compressor stations totaling 43,950 hp., planned.

Cie. de Recherche et d'Exploration de Petrole au Sahara, 530 miles, 16 inch, crude, Edjele field in Algeria to a port on Libyan coast, planned.

Consolidated Gathering Systems, Ltd., Calgary, 198 miles, crude, Sturgeon field to Edmonton, planned.

Cuban Gas Transmission Co., 650 miles, gas, from Campeche area of Mexico across Yucatan and under Gulf of Mexico to Havana, Cuba, 120 miles would be submarine, considered.

Development and Resources Corp., 70 miles, 8 inch, gas, from Agha Jari oil field to Ahwaz, Iran, planned.

East Coast Transmission Co. (Pacific Petroleums, Ltd., Home Oil, Ltd., Canadian Homestead Oil, Ltd. and Merrill Petroleums, Ltd.), crude, from Alberta to Toronto, considered.

Elburz Oil Corp., 1000 miles, big inch, crude, from Central Iran to Alexandretta, Turkey, $450 million, planned.

Entre Nazionali Idrocarburi, Rome, Italy, crude, from Qum field in Iran to the Mediterranean Sea, considered.

Federation Pipelines, Ltd., 125 miles, 10¾-inch, crude, main line, from Swan Hills area of Northern Alberta to Edmonton, planned.

Hydrocarbons Pipeline, Ltd., Winnipeg, Manitoba, 880 miles, 6-8 inch, products, from Edmonton to Winnipeg, $35 million, partial authorization.

Iraq Joint Venture Pipe Line, 1200 miles, 38-40 inch, crude, from head of Persian Gulf through Iraq to Turkish coast of Mediterranean, $840 million, planned.

National Iranian Oil Co., 146 miles, 6 inch, crude, from Azna to Isfahan, Iran, $5 million, planned.

1000 miles, 38 inch, crude, from central Iran to the Turkish Mediterranean coast, considered.

Petroargentina, Bahia Blanca, Argentina, 370 miles, 16 inch, crude, from Newguen to Bahia Blanca, Argentina, $40 million, planned.

Petroleos Mexicanos, 108 miles, 10 inch, gas, from Gral. Escobedo to Monclova to tie into Reynosa-Monterrey gas pipe line, $9 million, planned.

600 miles, 24 inch, gas, from Pemex City to Mexico City, $50 million, planned.

38 miles, 4 inch, products, from Mexico City to Toluca, $500,000 planned.

126 miles, 4, 6 and 8 inch, products, from Mexico City to Cuernavaca and Puebla, $2.5 million, planned.

Royal Dutch Shell Co., 155 miles, 24-30 inch, crude, from German Rhineland to mouth of Rhine River, planned.

Saskatchewan Power Corp., Regina, Sask., 80 miles, gas, Hatton gas field to Success, Sask., contract let to Engelking & James Ltd.

40 miles, gas, Moose Jaw to Regina, Sask., 124 miles, 10-inch, gas, main line, from Steelman to Regina, contracts let to Fulton Bannister Ltd.

Sui Gas Transmission Co., Multan, Punjab, India, 145 miles, 8-inch, gas, from Sylhet to Dacca, East Pakistan, $9 million, considered.

130 miles, 16-inch, gas, main line, Multan to Lyallpur, planned.

83 miles, 10-inch, gas, from Rohri section headquarters of Sui-Karachi line to main Multan line on East bank of Indus in the Bhung vicinity, Pakistan, planned.

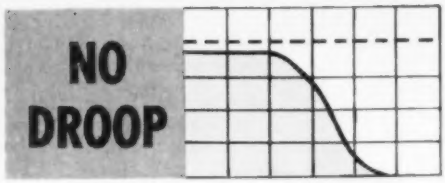
Trans-Europe Pipe Line, 700 miles, 30 inch, main trunk, crude, from Mediterranean to northern Europe, considered.

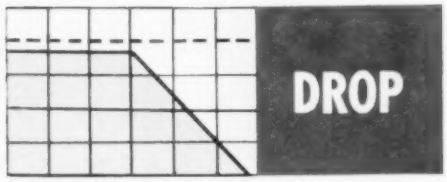
Westcoast Transmission Company, Ltd., 174 miles, 30-inch, gas, Savanna Creek gas field, Alberta, to British Columbian border, $45 million, planned.

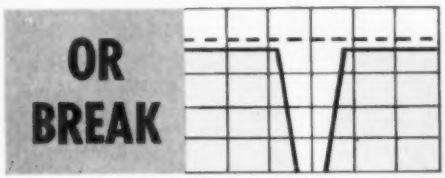
650 miles, crude, from Peace River area to Vancouver, $100 million, planned.

Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, 621 miles, 12-inch, products, Mendoza to San Lorenzo, Argentina, $19 million, planned.

281 miles, 12¾ inch, crude, Pichanal to San Miguel Tucuman to Techint, S. A., planned.







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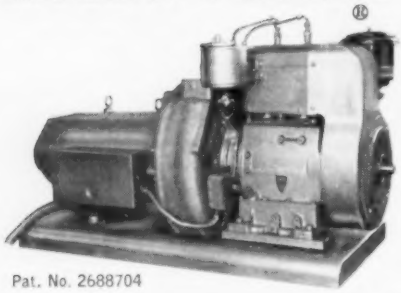

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What's Happening

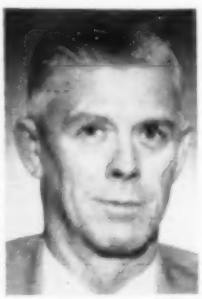
among MEN in the INDUSTRY

Mid-Continent Receives Safety Award

Mid-Continent Pipe Line Company has been named first place winner in the National Safety Council's contest for the Oil and Gas Pipe Line section, Class B. Mid-Continent had a perfect safety record for 1957 completing 648,011 man-hours of work without a single lost-time accident. Out of 36 companies competing, 10 had perfect scores, but Mid-Continent received the award because of its greater number of hours worked. The company will receive another plaque shortly, the Joseph Holmes Award of the Bureau of Mines of the U. S. Department of Interior. Admiring the Safety Council prize are, left to right, D. W. Van Vleck, manager of staff services; O. E. Bryant, vice president; and Jack Savage, safety director, Sunray Mid-Continent Oil Co., the parent firm.

Transcontinental Pipe Line Corporation announces the promotion of **Dan Williamson** from manager of Land department to vice president of the company.

Williamson, who has been with Transco since 1949, had been chief of acquisition when the company constructed its gas line extending from Texas to New York. He has been in right of way work since 1941 serving in executive capacities with such companies as **Ford, Bacon and Davis, Plantation Pipe Line Company, Robert and Company, Michigan-Wisconsin Pipe Line Co.,** and **Fish Constructors, Inc.**



Dan Williamson

•

The Buckeye Pipe Line Company announces the appointment of **Arthur J. Helmbrecht** as executive vice president. Helmbrecht has been associated with the company since 1935 when he served as assistant to the chief engineer. He became chief engineer, then was named assistant to the president and was elected vice president in 1955. Helmbrecht also is a member of the board of directors. He has served on numerous API committees and is currently chairman of the general information committee of the division of transportation.

•

Tennessee Gas Transmission Company announces the appointment of **A. L. Stegner,** technical administrative assistant to J. J. King, vice president.

Stegner had been corrosion and communications superintendent before his promotion.

•

Ross F. Madole has been named a director of the **Magnolia Pipe Line Company,** and **John W. Clark** has been elected a director and vice president of Magnolia. Madole succeeds **Davy Levy** who recently retired. He has been a member of Magnolia's Legal department since 1939. Clark is director in charge of exploration and

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Great industries are born of great ideas . . .

Natural gas, for example, was once an oddity of nature. Harnessed by the pipeline it has become one of America's key industries.

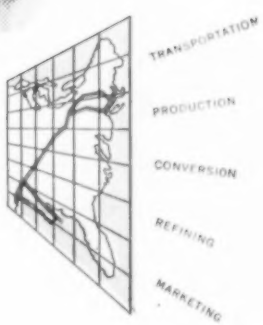
Tennessee Gas, the nation's longest pipeline, transports about two billion cubic feet of natural gas daily. It also explores for and produces gas and oil, extracts and converts their hydrocarbons, refines and markets the products of petroleum.

Today, we're active in every phase of the industry. Better equipped than ever to supply the heat, power, raw materials vital to our expanding economy.

TENNESSEE GAS TRANSMISSION COMPANY

AMERICA'S LEADING TRANSPORTER OF NATURAL GAS

HOUSTON, TEXAS



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will head Magnolia's oil and gas search in the 18 states making up the company's exploration territory.

•

Henry E. Littlehales has been appointed assistant director of public information for the **American Gas Association.** Succeeding Littlehales as manager of press relations is **Lorne S. Waddell.**

Littlehales joined A.G.A. in 1956. Previously, he had been in public relations with Rowe-Doherty Associates.

•

G. G. Billings is the new operations manager for **Shell Pipe Line Corporation** of Houston. Replacing him in his former post as manager of operating services will be **J. E. Green** who has been a technical specialist in the firm's management organization. Billings is a veteran of 21 years with Shell Pipe Line, and Green joined the company in 1940. Both men will headquarter in Houston.

•

Jerome K. Kuykendall is a new member of the **Federal Power Commission** and will serve until June 22, 1962, as chairman of the commission. Kuykendall first took office as a member of the commission in 1953 and served as chairman of the FPC during the entire period. He was formerly with the Washington Public Service Commission.

•

Harold Burrow

C. C. Johnson

Joe J. King

W. W. Witmer

Tennessee Gas Transmission Company has announced several advancements in administrative positions. **Harold Burrow** has been named first vice president and assistant to the president. **C. C. Johnson, Joe J. King** and **W. W. Witmer** were appointed senior vice presidents. Four vice presidents elected include **W. C. Braden, Jr., L. W. A. Campbell, O. H. Simonds, Jr.,** and **Stanley Ward.**

Burrow has been with Tennessee Gas since 1943 and was elected vice president in 1950. He became a senior vice president in 1954, directing the company's sales, supply and planning. Johnson joined the company in 1947 and was named treasurer in 1951. He has been a vice president since 1954. King has been associated with Tennessee Gas since 1946; was appointed chief engineer in 1949 and elected a vice president in 1951. Witmer, an attorney, joined the firm in 1951 and was made a vice president in 1954.

Prior to their promotions Braden had been director of certificates; Campbell, chief engineer; Simonds, director of sales, and Ward, director of taxes.

•

Texas Gas Transmission Corporation announces the appointment of four administrative positions. **James G. Elliot** has been promoted to superintendent of right-of-way for the nine-state area of Texas Gas Transmission. **W. T. Turner** and **M. E. Bless** were made division superintendents of land and lease, and **Frank Ramsey** is the new manager of Wilmot Compressor station.

James G. Elliot

Elliot, who has been with the company for 21 years, was division superintendent of land and lease. Burrill

Weldynamics

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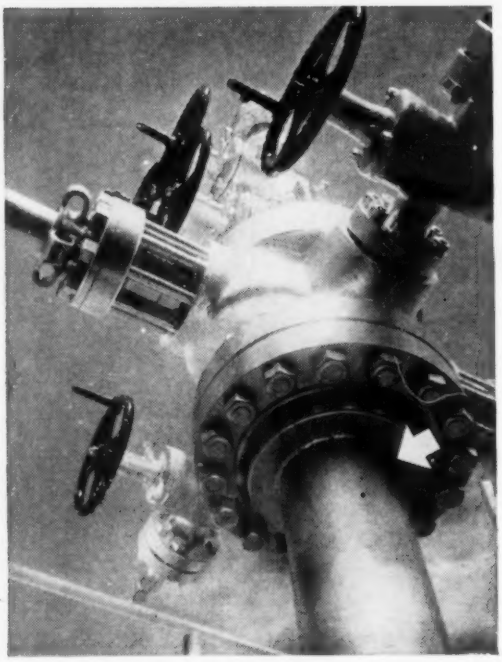

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T[illegible]lor and Truman D. Barnes, Jr., have been appointed district managers succeeding Turner and Bless. Ramsey has been with Texas Gas Transmission since 1946 and prior to his promotion had been assistant manager of Lake Cormorant, Miss., station.

•

Fred S. Jones has been promoted to superintendent of engineering and communications of **Platte Pipe Line Company.** Previous to his appointment, Jones had been superintendent of communications and electrical engineering. In his new position he will direct mechanical, hydraulic and civil engineering as well as communications and electrical engineering.

Fred S. Jones

Jones joined Platte in 1952 as a microwave technician and worked on the company's communications and remote control system.

•

Standard Oil Company (Indiana) announces several appointments in administrative positions. **Dr. Lawrence A. Kimpton** and **F. Cushing Smith** have been named to the board of directors. **Frank O. Prior** is the new chairman and chief executive officer, and **John E. Swearingen** is the new president.

Dr. Kimpton is chancellor of the University of Chicago. Smith has been general manager of the company's Supply and Transportation department. He joined the company in 1943 as a chemical engineer in the Research department, and in 1956 became assistant to the president.

Prior joined Standard in 1919. He was named executive vice president in 1951 and president in 1955. Swearingen, who has been associated with the company since 1939, was elected a director in 1952 and made executive vice president in 1956.

•

J. R. Ashley has been promoted to general superintendent of the Communications and Electrical department of the **Magnolia Petroleum Company.**

Ashley has been associated with Magnolia since 1927 and has held various supervisory jobs in West Texas around Kermit and Midland. He was promoted to assistant superintendent of the Communications and Electrical department in 1949.

J. R. Ashley

•

Michigan Consolidated Gas Company announces the appointment of **Norman E. Kenyon** as administrative assistant to the president.

Kenyon is a former newspaperman and public relations director. He spent 11 years as a feature writer with the Detroit Free Press and four years on the Pontiac Press staff.

•

H. D. Wilson has been appointed assistant division manager of **Sinclair Pipe Line Company's** Eastern Products division with headquarters at Marion, Ohio. **D. S. Kauffman** will succeed Wilson as district superintendent of Sinclair's Woodbury, N. J., office.

•

Claire F. Amies has been appointed field superintendent of the **Britamoil Pipe Line Company Limited.** Amies joined **Interprovincial Pipe Line Company** in 1949 and was district engineer with Interprovincial before becoming affiliated with Britamoil.

•

H. P. Letton, Jr., was elected to the board of directors and **H. A. Proctor** was named a vice president in charge of engineering and transmission by the **Southern California Gas Company.** Letton joined the company as an assistant general counsel in 1951 and was named general attorney in 1957.

Proctor's promotion followed the recent move of vice president **Grove Lawrence** to the **Pacific Lighting Gas Supply Co. S. A. Bradfield** will succeed Proctor as manager of engineering and **T. S. Miller** will move

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Branch Offices: 80 Broad Street, New York - Phone Digby 4-1949
209 Royalite Building, Calgary, Alberta, Canada — Phone AMhurst 6-6809
Maracaibo, Venezuela

to Bradfield's post as manager of transmission. Proctor has been with Southern California Gas Company since 1939, serving as administrative engineer of the Butadiene Production department. He became manager of engineering in 1948.

•

O. P. Carter has been elected president of the **Midwest Piping Company, Inc.**, succeeding the late **Eric A. Kerby.** Carter had been executive vice president since 1956.

O. P. Carter

He started with Midwest Piping 28 years ago as a sales engineer. Prior to his promotion to executive vice president Carter was manager of the company's New England division and East Coast construction for 10 years. He was chief engineer of Midwest operations during the construction of the atomic energy plant at Oak Ridge.

•

Clarence E. Goldsmith has been elected to the board of directors of **El Paso Natural Gas Company.** Goldsmith is a limited partner in White, Weld & Co., investment banking firm. He joined the banking firm in 1930, and from 1940 to 1956 he was a general partner.

•

Leslie H. True, president of the **Magnolia Pipe Line Company,** has been elected to the board of directors of the Mercantile National Bank, Dallas.

Leslie H. True

True is a member of the board of directors of Magnolia Pipe Line Company and **Magnolia Petroleum Company.** He has been with the company since 1922. In 1945 he was elected vice president and named to the board. He became president in 1952 and in 1957 was appointed to the board of Magnolia Petroleum Company. True is also a director of **South Saskatchewan Pipe Line Company** and **Project Five Pipe Line Corporation.**

DEATHS

Newell E. Loomis, consultant to the president of Michigan Consolidated Gas Company, died March 4, in Ann Arbor, Mich. Loomis had served as vice president and sales manager from 1949 to 1953. He joined the company in 1908 and became consultant to the president in 1953.

Hugh E. Smith, 67, retired Texas Illinois Natural Gas Pipeline Co. field superintendent of pipe lines, died March 13, at his home in Tulsa. Smith began his pipe line career with Natural Gas Pipeline Company 38 years ago. He had formerly worked for Empire Gas & Fuel Company.

For more data on advertised products, use Readers' Service Cards, last page.

WHO'S MEETING WHERE

May

LPGA, 27th annual convention, Conrad Hilton Hotel, Chicago, May 4-7.

Institute of Radio Engineers and American Institute of Electrical Engineers, 1958 Western Joint Computer conference, Ambassador Hotel, Los Angeles, May 4-7.

American Gas Association, distribution, production and transmission conference, Roosevelt and Commodore Hotels, New York, May 5-9.

Pacific Coast Gas Association, Technical Section Transmission Conference, Town and Country Hotel, San Diego, Calif., May 6-7, 1958.

Institute of Radio Engineers and American Institute of Electrical Engineers, Western Joint Computer Conference, Ambassador Hotel, Los Angeles, May 6-8.

API, Division of Production, Eastern District Meeting, Deshler-Hilton Hotel, Columbus, Ohio, May 7-9.

Southeastern Gas Association, Gas Sales Conference, Selwyn Hotel, Charlotte, N. C., May 9.

Fluid Controls Institute, Spring Meeting, Lake Placid Club, New York, May 11-13.

American Society of Mechanical Engineers, Oil & Gas Power Division 30th annual conference and exhibit, Philadelphia, Pa., May 12-15.

Second Annual Stationary Industrial Engines course, sponsored by University of Oklahoma, at Norman, Okla., May 13-14.

NEGA, Operating Division, Sheraton-Biltmore Hotel, Providence, R. I., May 15.

National Fire Protection Association, Annual Meeting, Palmer House, Chicago, May 19-23.

Pennsylvania Gas Association, annual meeting, Pocono Manor Inn, Pocono Manor, Pa., May 20-22.

Rocky Mountain Oil and Gas Association, thirteenth annual convention, Cosmopolitan Hotel, Denver, May 21-23.

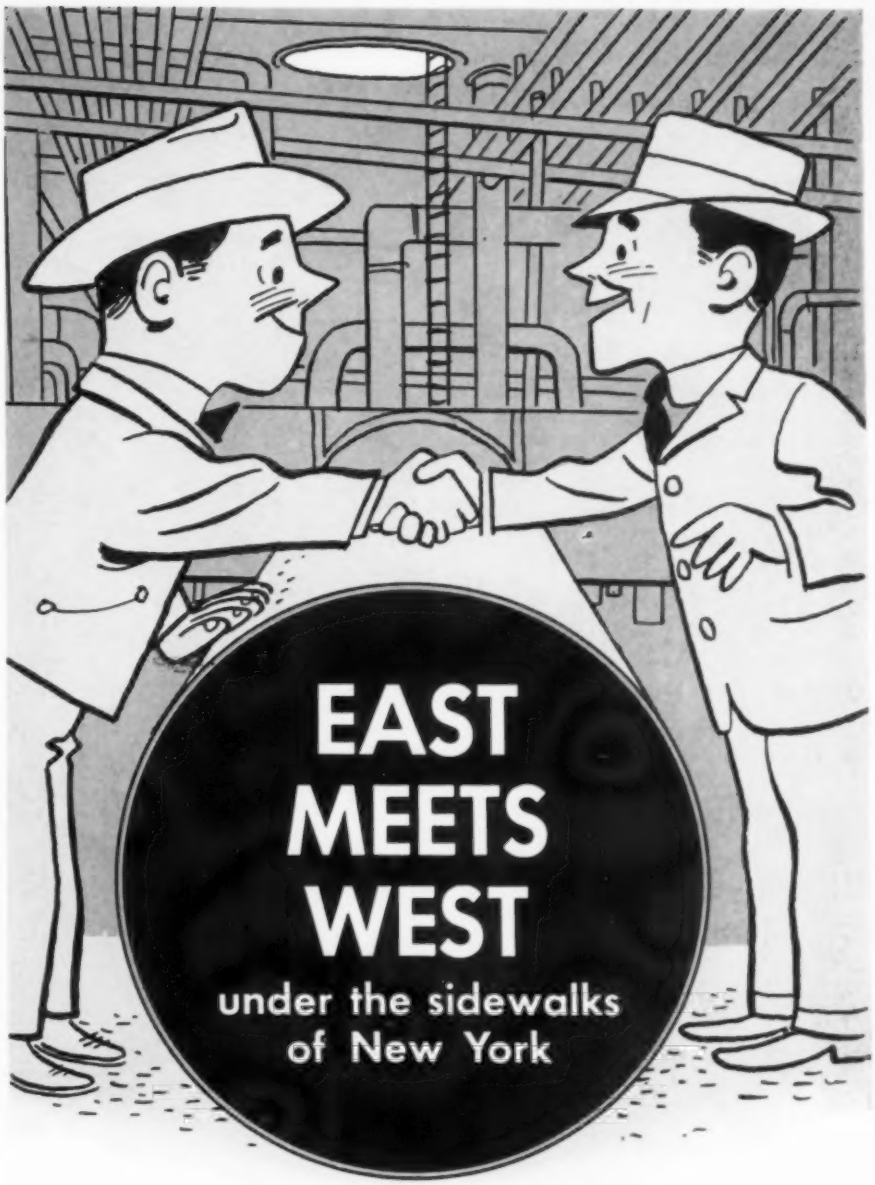
API, Division of Production, Pacific Coast District Meeting, Biltmore Hotel, Los Angeles, May 22-23.

Natural Gas and Petroleum Association of Canada, Annual Meeting, Windsor, Ont., May 22-23.

Annual Short Course in Gas Technology, Texas College of Arts and Industries, Kingsville, Texas, May 27-29.

June

I.L.P.A. 30th annual meeting, Texas Hotel, Fort Worth, Texas, June 2-4.



Natural gas consumers on the eastern seaboard never give a thought to the old maxim about that gap between East and West. Under their cities run dependable connecting pipelines to gas fields west of the distant Mississippi. Transco is privileged to take your gas where the most people are: through Transco the twain will always meet to their mutual advantage.

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

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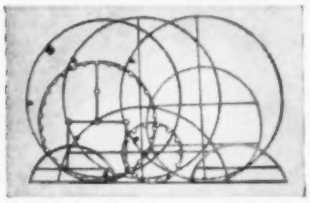
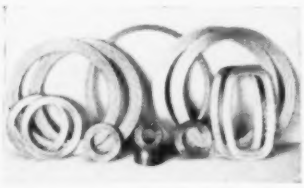
For Every Purpose



HEAT EXCHANGER GASKETS

Made in any size or shape needed in double jacket type. Also cut from solid metal or sheet packing. Write for Bulletin 564.



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SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.

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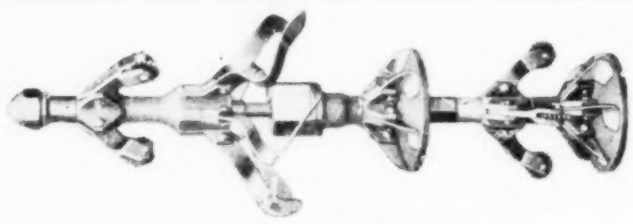
What's Happening among SERVICE and SUPPLY MEN

Caterpillar Presents Desk Set

James Neil, right, last year's president of the Pipeline Contractors Association, receives a model pipelayer desk set presented by J. J. Valentine of Caterpillar Tractor Company at the annual contractors convention in Boca Raton, Fla. Five past presidents of the association were also presented with desk sets by Caterpillar.

Go-Devil



Standard Model Northrup Go-Devil with leather disc drivers

G. A. COTTEN CO.

Manufacturer of

NORTHRUP GO-DEVILS & TRANSIT PIPE LINE SCRAPERS

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T. J. Behrenfeld

Clare G. Miller

M. J. Crose Co. Appoints New President and Vice President

Clare G. Miller is the new president, and T. J. Behrenfeld has been appointed vice president of the M. J. Crose Manufacturing Company, Inc. The appointments followed the resignation of President D. Michael Curran, who will remain active as a company consultant.

Miller had been vice president of Crose for the past three years. Behrenfeld joined the company nine years ago and was sales manager for the past two years. Previously, he had opened and managed the Crose Houston division for three years. Miller owned and operated the Texas Road Boring Company in Houston before joining Crose.

Milton Nelson

Gordon Mott

Six Appointments Announced By Dresser Industries, Inc.

Six new appointments have been announced by Dresser Manufacturing Division, Dresser Industries, Inc. Hilton H. Nelson has been promoted from controller to treasurer, and Gordon E. Mott has succeeded Nelson. William J. C. Marshall, Jr., has been appointed general market sales representative for New England, and C. E. Boston has been named general market sales representative for northern California and western Nevada.

John T. Dunton and Howard Hoke become engineering managers in charge of pipe joining products and fittings, and pipe repair products, respectively.

Indiana-Ohio Pipe Company Purchases 136 Miles of Pipe

The Indiana-Ohio Pipe Co. purchased [illegible] miles of 8-inch pipe from The Ohio Oil Company. The line extends from Bluffton, Ind., to Lima, Ohio. The 8-inch crude line has been replaced by 18-inch lines. Indiana-Ohio will begin taking up the line in May.

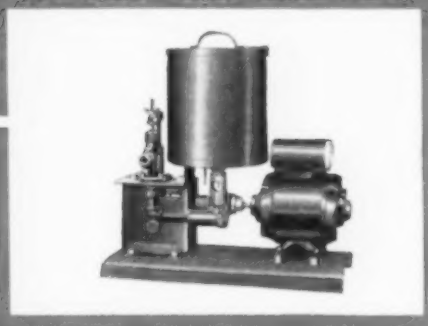
Process Fabricators, Inc. Acquires Facilities, Plant

Process Fabricators, Inc., a new firm with headquarters in Houston, has acquired the plant and manufacturing facili-

assures precision metering!

CHEMICAL FEEDERS by Manzel give accurate, dependable metering of chemicals, acids, oils, and many other liquids. Rugged, trouble-free units are available in large or small capacities, with single or multi feeds, for any type of drive. Delivery from one cc/min/feed to one gal/min/feed, against pressures to 5000 psi. Consult your Manzel field engineer for full details and recommendations.

MANZEL



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Proved on gas and steam lines, as well as on lines carrying heavy or viscous liquids, this valve easily closes TIGHT—with absolutely NO LEAKAGE—and just as easily opens for full, unobstructed flow.

After the lever lowers the gate into the closed position, plastic lubricant is forced by means of a screw down through the channels so that the faces of the gate are sealed tight against the valve body. To open the valve, the screw is backed off to relieve lubricant pressure.

That's all. It's rugged, simple, easy to operate, practically fool-proof in even the toughest service. Available in pipe sizes to 2½"; larger sizes available soon.

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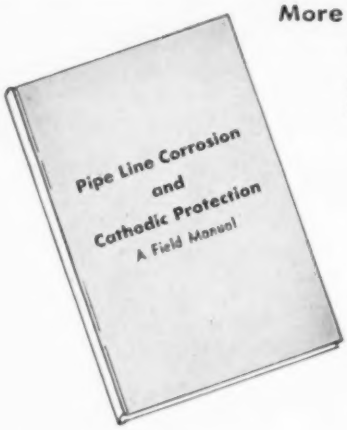
More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."



Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

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ties of the United Pipe Fabricating Co., Inc., Houston.

Officers of the new company are G. Bryan, president; George E. Little, executive vice president; and Edward W. Berry, secretary and treasurer.

Process Fabricators, Inc. will fabricate process piping for the refining, petrochemical, pipe line and power industries. The plant is equipped to handle carbon and a full range of alloys.

Philip Goodwin, Jr.

William Shenkle

Rockwell Manufacturing Names General Manager Appointments

Rockwell Manufacturing Company announces two promotions in managerial positions. William H. Shenkle has been made general manager of the Instrument division in Tulsa, and Philip E. W. Goodwin, Jr., has been named general manager of the company's new 180,000 square-foot valve plant at Kearney, Neb.

Shenkle has been chief engineer of the Instrument division, and Goodwin previously was general manager of the Sulphur Springs, Texas, valve plant. Shenkle joined Rockwell in 1953 as a products engineer, and Goodwin has been with the company since 1944.

Robert Sutherland Appointed To Manage New Branch Office

C. Lee Cook Company, Louisville, a division of Dover Corporation, announces the opening of a branch office and warehouse in Los Angeles. Robert D. Sutherland has been appointed branch manager. Sutherland spent several years with Ingersoll-Rand and later joined Worthington Corporation as sales engineer. He had also been head of Mechanical Equipment section of Ralph M. Parsons Company prior to joining Cook.

R. D. Sutherland

National Cylinder Gas Co. Directors Vote for New Name

Directors of the National Cylinder Gas Company have voted to change the name of their company and are asking stockholders to approve the name "Chemetron Corporation."

President Charles J. Haines said that the company has outgrown the name National Cylinder Gas Company. Chemetron is made up of parts of names of three major industries served by the company — chemical, metal and electronics.

National Cylinder is now producing industrial and medical gases; welding and

curing equipment; welding fittings and flanges for piping systems; custom forging and engineering design and construction of complete process plants for the chemical, petroleum and other industries.

The company and its subsidiaries have 81 plants in 31 states and 14 plants in other countries.

Philip Wallach Appointed Nordberg District Manager

Philip Wallach has been appointed district manager of the Great Lakes territory of the Engine Division of Nordberg Manufacturing Company. Wallach joined the company in 1956 and since that time he has concentrated his efforts in the marine, utility and pipe line markets. The Great Lakes territory includes Michigan, Indiana, Ohio, West Virginia, western Pennsylvania, western New York and the greater Toronto, Ontario area. Wallach will also follow marine engine application for Great Lakes and inland waterways. He succeeds G. B. Wright, who recently resigned.

Philip Wallach

PROCESS ENGINEERS

Foreign Employment

Career opportunities for graduate engineers in Saudi Arabia. To provide technical service to operating department in pipe line, pump stations and related power facilities. B.S. in chemical engineering, petroleum engineering or mechanical engineering required. Experience required: 3-5 years in industrial process plants, including engineering design and operation of oil handling and process plants or equivalent. Salary commensurate with experience. Excellent community facilities. Write giving full particulars regarding personal history and work experience.

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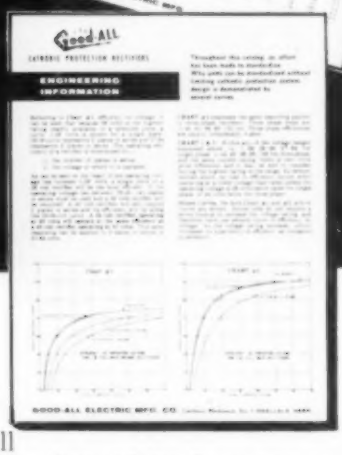
CATHODIC PROTECTION RECTIFIERS



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CUSTOM-AIR

Air cooled, lightweight and compact. Highly efficient. Individually designed stacks and transformers.

FEATURES: All contacts and terminals silver plated. Circuit breakers with instantaneous and time delay trips. 20 D-C output steps from zero to full rating. Rugged steel case with front, sides and top removable for easy access.

CUSTOM OIL

For extremely dusty, contaminated or humid areas.

FEATURES: New case design adds 10-15% greater cooling capacity. All components enclosed in case, with "easy to open" toggle-latch top. Oil creep problem eliminated. All "Custom" specifications.

ADD-A-STACK

Flexible design. Stacks may be quickly added or removed, wired in parallel, series, or series-parallel combinations to obtain great variety of outputs.

DESIGNED FOR: Single phase installations where ground bed resistance varies or current requirements can't be determined in advance, or installations where a change in requirements is anticipated.

TYPE-N

For **LOW COST** protection of Distribution Systems, wells, storage tanks, etc. A small, custom quality, oil immersed rectifier-at prices lower than an air cooled rectifier of equivalent rating.

FEATURES: Output easily adjusts with silver contact switch. Attractive steel case —grey Hammertone baked enamel finish.

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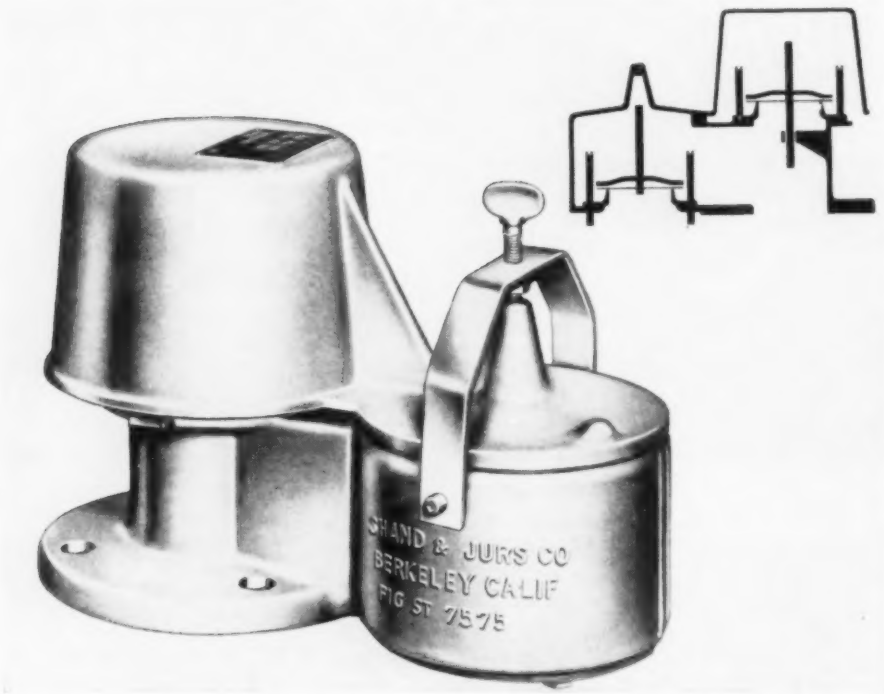
(Write GOOD-ALL for Representative list)

GOOD-ALL ELECTRIC MFG. CO.

ELECTRICAL MECHANICAL DIV. 122 W. 1ST ST., OGALLALA, NEBRASKA

What's New in EQUIPMENT



Breather Valve

Shand and Jurs Company announces the addition of a 3-inch diaphragm-type breather valve to its line of mechanical storage tank fittings. The small size valve complements the existing 4, 6, 8, 10 and 12-inch sizes already offered in the ST-7575 series.

The valve features diaphragm-type pallets which maintain an efficient vapor-tight seal at tank pressures and vacuums less than settings. The "balanced-diaphragm action" assures seal against leakage throughout the range of pressures and vacuums. Simple construction, compact design and rugged durability provide high flow capacities at relatively small pressure or vacuum beyond vent settings.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Ground Clamp

An improved line of arc welding ground clamps equipped with ball-point type cable connection has been announced by Tweco Products, Inc. With the ball-point cable connection a welder can attach a Tweco ground clamp to a welding cable in approximately two minutes.

The new connection is simple in design. A cable socket is drilled in the clamp casting and at right angles to this socket another hole is drilled and tapped. Both holes are drilled 9/16 inch. A cadmium plated ball-point steel screw goes in the tapped hole.

To install a clamp the welder strips 1 inch of cable jacket, inserts the bare cable in the cable socket and tightens the ball-point screw directly on the cable strands. A hex drive wrench is used, allowing tremendous pressure to be applied. A formed steel ring attached to the clamp is then tightened around the cable jacket.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Station Amplifiers

General Electric Company announces the addition of two base station amplifiers, designed to provide up to 330 watts of power and greatly increase the signal transmitted from the dispatcher's position in a two-way radio system.

The new high powered communication units are engineered to provide increased coverage and to improve reception in vehicles traveling at great distances from the transmitter. The equipment can be used with low and high band frequencies.

The amplifiers also include automatic voltage regulation, a built-in test meter to measure power output and simplified tuning. The units are available for local control, extended local control, remote control and repeater operations.

(This item supplements General Electric Company data on Pages 181-188 of the Pipe Line Composite Catalog, 1st Edition.)

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

Pigment

National Lead Company has developed a new form of pigment for protective painting systems. The M50 pigment consists of a silica core on the surface of which basic lead chromate has been fused. The product thus has rust-inhibitive properties of lead and chromium compounds and the weather resistance of fused basic lead chromate. The pigment can be tinted and therefore permits production of metal protective paints in variety of colors.

More than 2,200 individual weather exposure tests have been made on M50 pigment over a period of more than nine years. It has excellent chalk resistance, which allows it to be utilized in prime coat paints for new fabricated steel, with no loss of corrosion protection due to excessive and rapid chalking prior to field coating.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

Gas Sampler

A new automatic gas sampler has been developed by Gilbert & Barker Mfg. Company. The sampler takes dependable and low cost samplings in pipe lines for analysis, quality control and stream blending. It is designed for continuous operation in obtaining truly typical gas specimens with ease and complete weather protection of the sample and sampler components. A sampling container is enclosed within a weatherproof housing for safety from tampering and the elements.

Gas, under line pressure, enters the sampler through a fine mesh monel strainer. This screen, replaceable with a strainer of any mesh, prevents pipe scale and foreign particles from entering the system. Pressure is reduced in a pressure-reducing valve and the sample is tapped in a measuring chamber by two electrically timed solenoid valves. The sample is then discharged at controlled intervals into the gas sampling bag for laboratory analysis.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

For **superior protection of** underground **structures**

DURIRON® ANODES

3 year-old installation jetted in WITHOUT BACKFILL shows no loss of protection

This actual installation graphically demonstrates Duriron's ease of installation and economy factors.

Twenty Duriron Anodes were installed to protect a pipe line in a creek bed area where sandy soil prevented backfilling. These anodes were jetted into place in the vertical position using a high velocity stream of water, and were placed with the top of the anodes 3 feet below the surface. *Each anode was in position within 60 seconds.*

The group of anodes produced an average of 33 amps at 36 volts with no tendency to gas block. Actually, the bed resistance has decreased since the original installation. There was considerable cost-saving in the elimination of carbonaceous backfill.

- Duriron anodes, bare or with backfill, resist all current densities common to ground bed applications.
- Duriron resists all soils. Care required only when operating at high current densities in high chloride areas.
- Duriron has dense structure. Will not absorb moisture or gases causing breakdown. High weight factor gives longer life per anode size.
- Duriron has good electrical conductivity. Minimizes heavy current discharge near connection for uniform consumption.
- Duriron is mechanically strong. Metal-to-metal contact avoids loss of protection due to poor connection.

THE DURIRON COMPANY, INC.
DAYTON, OHIO

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

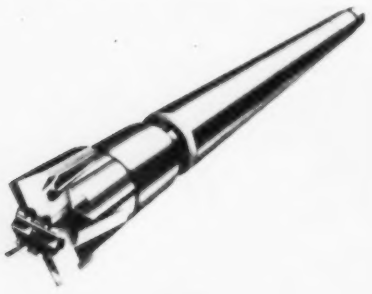
SEE BULLETIN DA/2

For **superior protection of** underground **structures**

DURIRON® ANODES

Rotatool Drill

Schramm, Inc., announces a new percussion tool, Rotatool, which makes possible fast, economical drilling in hard rock formations that stop ordinary rotary drills. The Rotatool, developed for use with the Schramm Rotadrills, has only three moving parts. It has a heavier hammer which allows greater fracturing action for faster penetration. A special bit equipped with six carbide tips is designed for maximum life with minimum wear.



Rotatool can be used in field work requiring large cut and fill operations in construction work, blast hole work in quarries, water well drilling, strip mining, submarine work (river crossings and channel deepening) and military applications.

(This item supplements Schramm, Inc., data on Pages 346-347 of the Pipe Line Composite Catalog, 1st Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

WISCONSIN-Powered high pressure pipe line unit

...keeps oil "ON THE MOVE" from 4 properties...

OPERATING on L.P.G. (chiefly butane to meet climatic conditions and lack of casinghead gas), this pumping unit transports crude oil from four separate properties to the Crown Central Pipe Line Company's refinery at Pasadena, Texas.

The unit is driven by a WISCONSIN Model VG4D V-type, 37 hp., 4-cylinder heavy-duty air-cooled engine, equipped with clutch and electric starter. No generator is required as the Gauger carries a heavy-duty battery in his car for starting and trouble-shooting when necessary. The engine is belted to an H-50 Roper pump, handling about 50 bbls. per hour at 500 lbs. pressure.

This is an assignment that calls for load-lugging high torque performance, heavy-duty serviceability and trouble-free all-weather AIR-COOLING at all temperatures up to 140°F. The engine is equipped with Stellite exhaust valves and valve seat inserts and positive type valve rotators. This adds from 200% to 500% to valve life with comparable maintenance economies.

Extensively used in oil fields everywhere for oil well pumping, pipe line service, pipe line wrapping machines, tar kettles, trenchers and a great variety of oil field utility units . . . Wisconsin Heavy-Duty Air-Cooled Engines rate top preference among power-wise oil field operators.

YOU can't go wrong if you specify "WISCONSIN" for YOUR equipment.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

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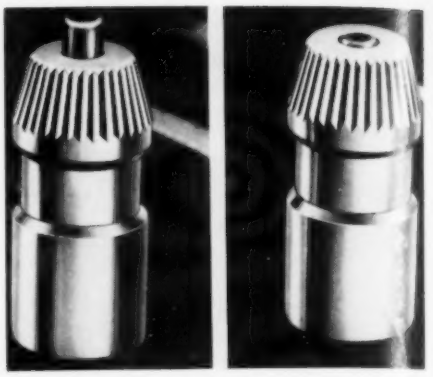
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A8-6186



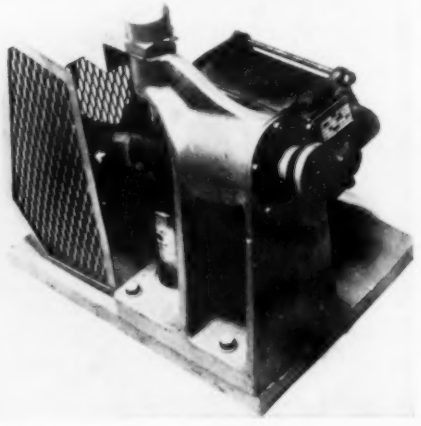
Pressure Indicators

Designed to eliminate the inherent dangers and costs that result from under inflation of tires, the No-Lo Tire Pressure Indicator has been developed by the Trebank Company.

Used to save time and money and as a safety precaution, the indicators which screw into the valve stem of each tire, actually constitute miniature pressure gages.

Drop in the air pressure is indicated when the red tip of a pressure control rod slides back into the valve where it cannot be seen. When the air is at a safe level, the red rod remains visible and driver or maintenance man need only glance at the indicator to tell whether the tire is safe for proper operation.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



Chemical Injector

Texsteam Corporation announces a variable volume electric-driven injector designed to pressure-deliver accurately measured quantities of hot or cold compounds covering a wide viscosity range. The injector is powered by a 1¼ horsepower, 1750 rpm explosion proof or fully enclosed electric motor geared down to non-fluctuating 48 rpm. Automatic or remote control mechanisms are easily adapted.

Power is transmitted from the gear motor through a positive mechanical linkage and reciprocating arm connecting the plunger. The linkage is designed to return the plunger to full bottom position regardless of stroke length. Complete chemical displacement per cycle, plus uniform plunger and packer wear is assured by this feature. The injector will deliver volumes ranging from .5 gallon per hour at 7,000 psi to 2.5 gph at 1,200 psi with the ½-inch plunger, or 4.4 gph at 7,000 psi to 12.75 gph at atmospheric pressure with the 1-inch plunger.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

BEST . . .

FOR

HANDLING

COATED

PIPE

THE C·R·C PIPE SLING

Made especially for pipeline use, the C·R·C Pipe Sling permits safer handling of coated pipe. The sling is rubber covered and steel reinforced. Strong, but flexible, interlocking wire links enclosed in rubber give this belt high tensile strength . . . ultimate lifting capacity is 180,000 lbs. on 36 in. pipe size sling. Yet, the sling is just 5/8 in. thick for free usage in tight ditches. Call us for more details.

MAX. PIPE SIZE	PIPE SLING DIMENSIONS	SLING WEIGHT	IRON WEIGHT	ULTIMATE LIFTING CAPACITY
36"	12' 6"x30"x5/8"	237#	103#	180,000#
30"	10'x24"x5/8"	154#	84#	144,000#
24"	8'x20"x5/8"	106#	70#	120,000#
18"	6' 3"x16"x5/8"	71#	56#	96,000#
12"	4' 6"x12"x5/8"	39#	42#	72,000#

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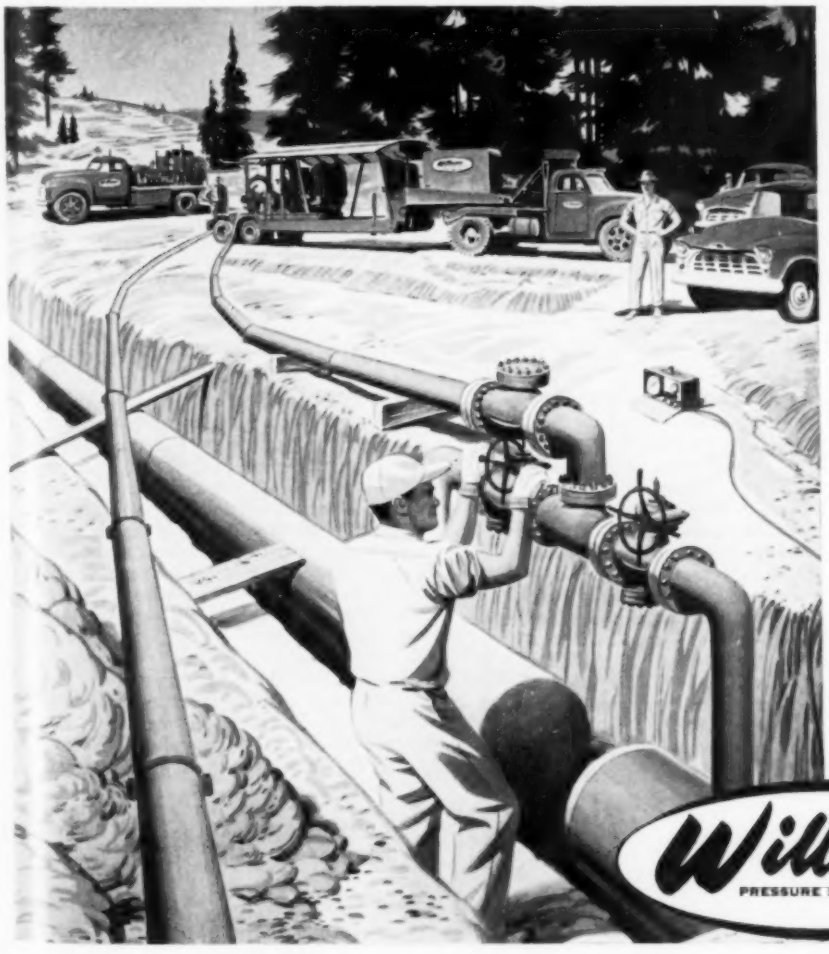

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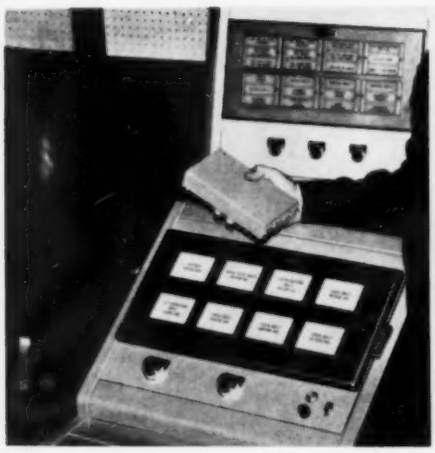
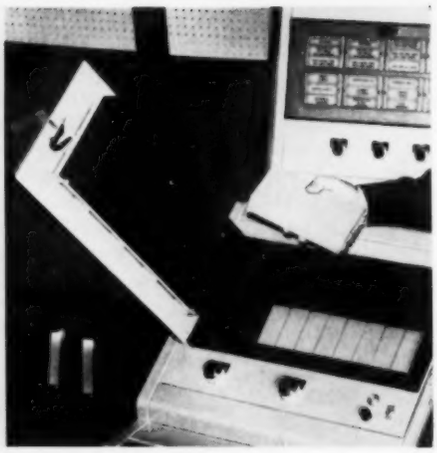




Static-Magnetic Annunciator

Panalarm Division of Panellit, Inc., has developed a new type annunciator for monitoring complex automatic systems. The annunciator uses static-magnetic controls in place of the precision relays used in Panalarm's conventional annunciator.

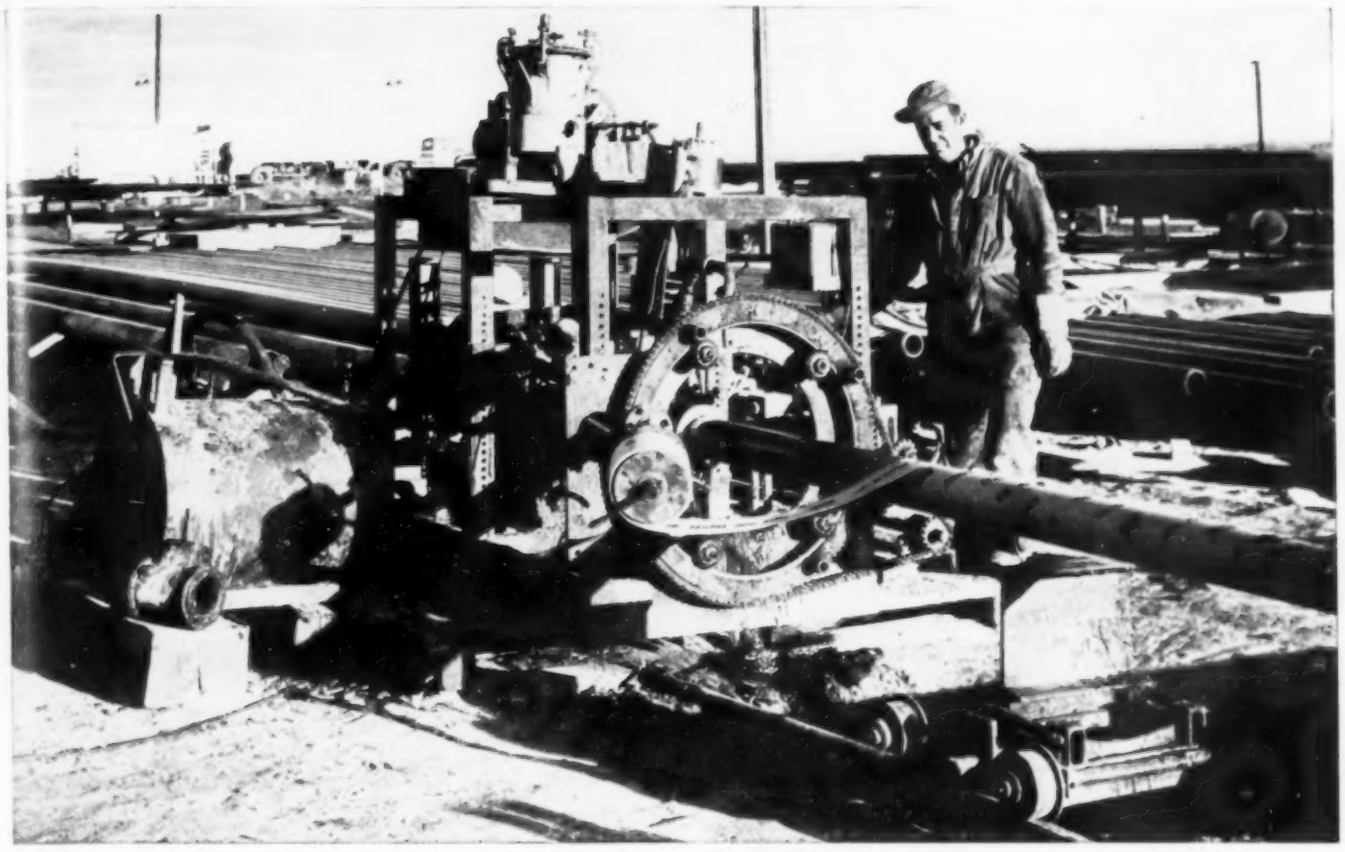
It reports "off-normal" occurrences by both visual and audible means on an instrument type panel. The annunciator controls have no moving parts and provide a high degree of reliability for monitoring critical operations or conditions. The static-magnetic units have a plug-in design which makes it possible to change sequences without rewiring, or to expand the system as required.

The annunciator is particularly applicable to industrial systems where interlock or automatic shutdown are involved.

(This item supplements Panellit, Inc. data on Page 321 of the Pipe Line Composite Catalog, 1st Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

PROVED BY MILES & MILES & MILES &



TARSET® Protects High Temperature Gas Injection Lines from Corrosion in Elk City Field

GAS injection lines serving the Hoxbar Unit in the Elk City, Oklahoma oil and gas field face some very tough underground corrosion conditions.

Operated by the Shell Oil Company for Shell and 31 other participating members, the Elk City Processing and Gas Cycling Plant recycles gas through the injection lines to 15 injection wells, maintaining reservoir pressure and increasing the field's ultimate recovery.

Because the carbon steel injection lines carry gases up to 230°F. and pass through spots where trapped water creates very corrosive conditions, the lines soon began to corrode despite heavy wall thicknesses.

Shell recently reconditioned the injection line system—some six miles of pipe—and coated the lines with Pitt Chem *Tarset*. A patented coal tar-epoxy resin coating, *Tarset* was selected because of its excellent service record in the petroleum industry and its ability to withstand high temperatures and corrosion conditions. *Tarset* was applied by spraying. Future coating may be done by the experimental machine illustrated above.

What's *your* toughest corrosion control problem? Perhaps tough, durable, cold-applied Pitt Chem *Tarset* can solve it for you. *Tarset* is available through your local Industrial Distributor. *Call him for more information today!*

Think First of the Coatings that Last!

- ★ **PITT CHEM** Coal Tar Coatings
- ★ **PITT CHEM** "Insul-Mastic" Gilsonite Coatings
- ★ **PITT CHEM** "Tarset" Coal Tar-Epoxy Resin Coating

PITT CHEM Industrial Coatings are available through leading Industrial Distributors. See the "Yellow Pages."

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PITTSBURGH COKE & CHEMICAL CO.
Grant Building • Pittsburgh 19, Pa.

WSW 7139

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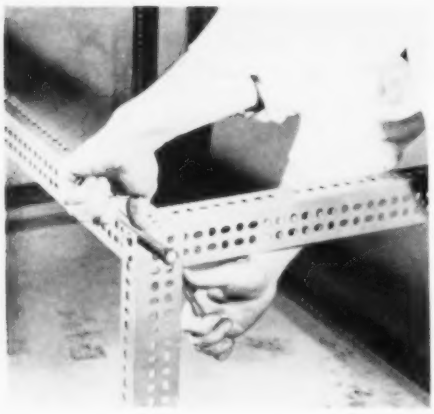
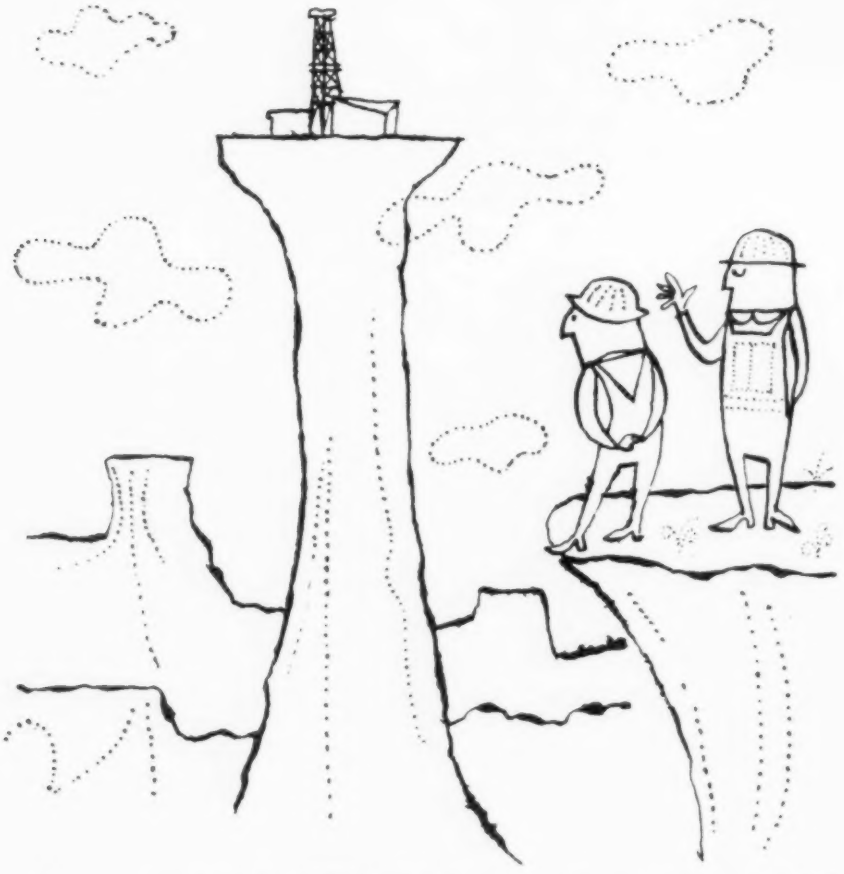


Framework

Republic Steel Corporation's Berger Division announces quick-assembly all-steel framework to form everything from storage racks to shed-type buildings. Each package of Bild-A-Flex contains 10 lengths of steel framing, in 10-feet or 12-feet sizes, and 75 sets of matched nuts and bolts. The lengths are pre-punched with a pattern of slots. For construction, a worker merely cuts appropriate lengths and bolts them together through the slots.

Units can be reconstructed after one has served its purpose. Additional beam capacity to support heavier loads can be achieved by combining lengths of the framing into I, T, U or other rectangular shapes. Both the .080 ga. and .104 ga. steel framing are interchangeable and can be combined for varied design requirements. Another accessory is a 6-inch wide panel available in lengths from 36 to 60 inches in 6-inch increments. It is used as a load-bearing surface, such as the floor of a mezzanine, treads for stairs and ramps, and working surfaces for assembly tables and machinery benches.

For more data, circle **No. E11** on Readers' Service Card, last page this issue.



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Parkhill has the men, the equipment
and the experience to handle your next pipe
stringing job, large or small. Give us a call
and park your problems with Parkhill.

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All-Aluminum Connector

An all-aluminum connector for semi-flexible transmission lines, registered under the name of Spir-O-Line, is announced by Prodelin, Inc. Spir-O-Line cable and connector is an assembly which does not require special tools and employs simple techniques that eliminate the need for lengthy field assembly time. The connector also can be assembled hand tight without wrenches for laboratory or emergency application.

The connectors can be used repeatedly without redressing tubing or replacing connector parts.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

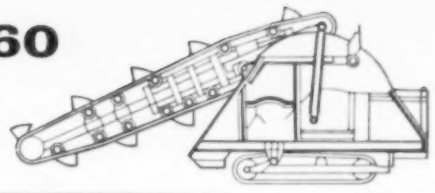
Warning Lights

Pacific Mercury has announced a new flasher warning light, available in both neon and transistor models. Both models have the operating mechanism sealed in plastic.

There is an ALLEN TRENCHER for every job!

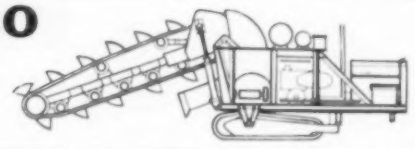
16-60

.10m. to 1.52m. wide. 4.26m. max. depth.



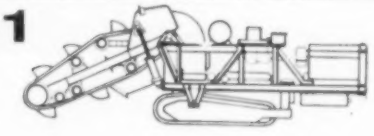
14-30

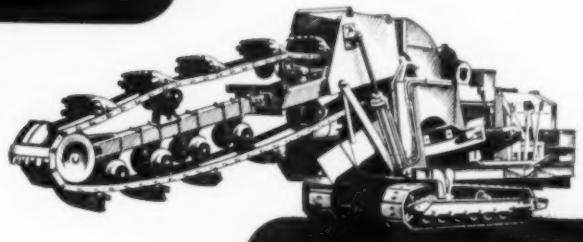
.35m. to .78m. wide. 2.59m. max. depth.



12-21

.30m. to .53m. wide. 1.82m. max. depth.





All over the world Allen Trenchers are proving their superiority for digging clean, precise trenches quickly, with freedom from breakdown and economy in operation. If you have a trench-digging problem, one of the Allen "built to last" range will provide the answer.

Full particulars of all Allen earth moving equipment sent on request.

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Serving the Pipeline Industry
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Lights are vapor-proof, impact resistant, and will operate with top efficiency in any climate. The lights can be used around breakdown of trucks, construction jobs and other field work. Cast aluminum housing makes the product extremely rugged, all but eliminates damage from collision and insures long life. Lenses have a quadruple thickness and of optical quality making little need for lens replacement. Design of the light gives 7,000 to 12,000-foot visibility in either direction during the entire battery life of the neon flasher. The transistorized flasher has a visibility extending 4,000 to 5,500 feet.

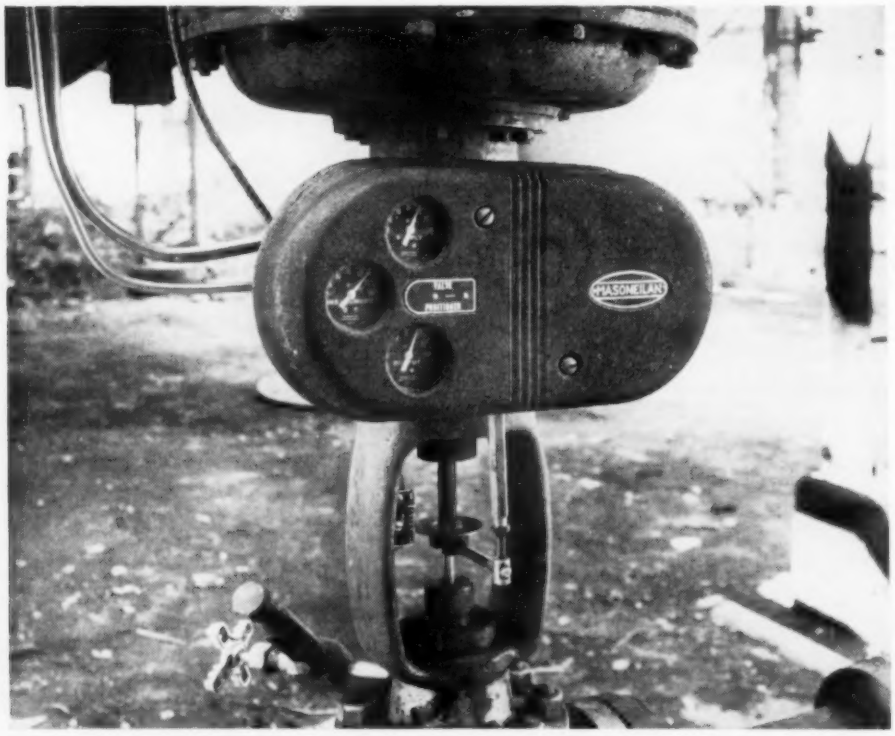
For more data, circle **No. E13** on Readers' Service Card, last page this issue.

Density System

An accuray density system for measuring and/or controlling fluid density, specific gravity, percent solids or related quantity has been announced by Industrial Nucleonics Corporation. It is applicable to liquids, slurries and flaked, granulated, powdered or other divided solids. The system is based on principles of gamma ray transmission from a radioisotope and makes no physical contact with the flowing material.

The measuring head of the system is constructed of heavy corrosion resistant castings welded on a section of pipe. It is designed with maximum stability and ruggedness to withstand shock and vibration under the most adverse industrial conditions. Pipe sizes from 3 to 8 inches are standard; other sizes are available. The power supply amplifier instrument may be located hundreds of feet from the measuring head.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.



For precise pneumatic control operation . . .

Come to Kemp

Put an end to pneumatic control stoppages due to freezing, corrosion, and vapor locks. Install famous Kemp Oriad Dryers on your air lines to remove moisture and dirt. . .keep controls and delicate instruments operating smoothly and accurately.

Kemp Oriad Dryers on your lines cost surprisingly little. . . upkeep and maintenance costs are negligible. Rugged Kemp design keeps dryers operating perfectly, year after year.

Call your Kemp Representative or write us direct for Bulletins D-102 and D-103. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

KEMP
OF BALTIMORE

Available in all sizes for automatic, semi-automatic, or manual operation. Steam or electric reactivation.

Thermometers

W. H. Curtin & Co. announces its "Yellow-Mite" midget type industrial thermometer which is precision engineered for installation requiring small, accurate thermometers.

The thermometers, amply protected and rugged enough for years of service, are suited for installation in product pipe lines, tanks, power plants etc. and other applications requiring fast, accurate and dependable readings.

They are available in two styles, the "straight" (A) and the "angle" (B) covering a range from –30 to 700° F. Length of well below threads is available in either 2, 4 or 6 inches and in all ranges. Thermometer tube may be replaced without removing well providing there is proper clearance to turn the casing.

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

here's important

new economy for you

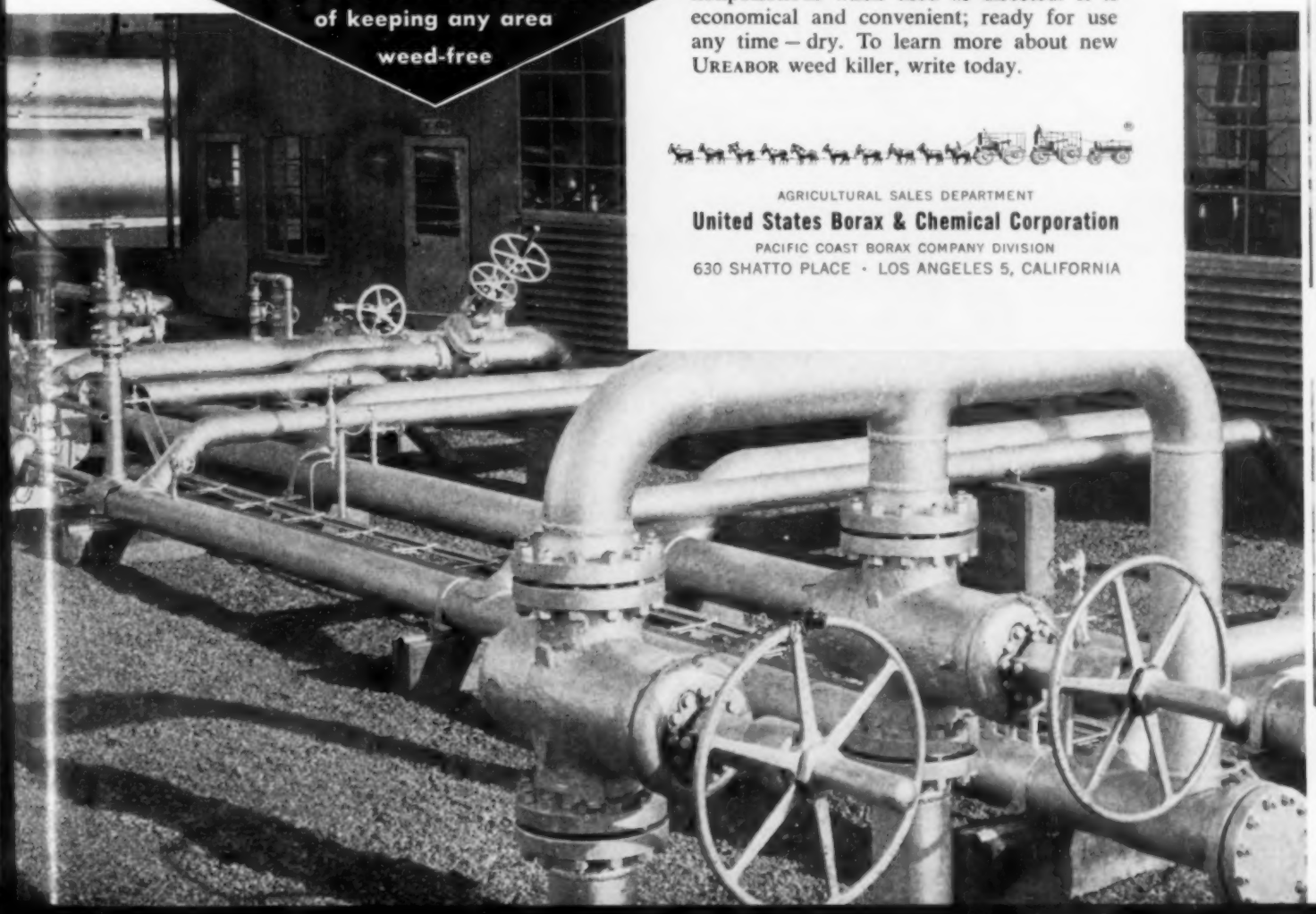
in weed control...

UREABOR® weed killer is a dependable performer. It's effective, easy to apply, low in cost, and provides long residual action. Now, for as little as 30¢ per 100 sq. ft., you can control vegetation for a full year in areas like the one shown here.

Granular, dust-free UREABOR is applied at low rates in its delivered form...dry. There's no mixing...no water to haul...no need for cumbersome spray rigs. UREABOR may be applied by hand. For most efficient treatment of large areas, a small special hand-operated spreader is available for $10.75 delivered, anywhere in the U.S.A.

UREABOR weed killer is safe – it is nonvolatile, nonflammable, noncorrosive and nonpoisonous when used as directed. It is economical and convenient; ready for use any time – dry. To learn more about new UREABOR weed killer, write today.

This new chemical can prove to be your most practical way of keeping any area weed-free



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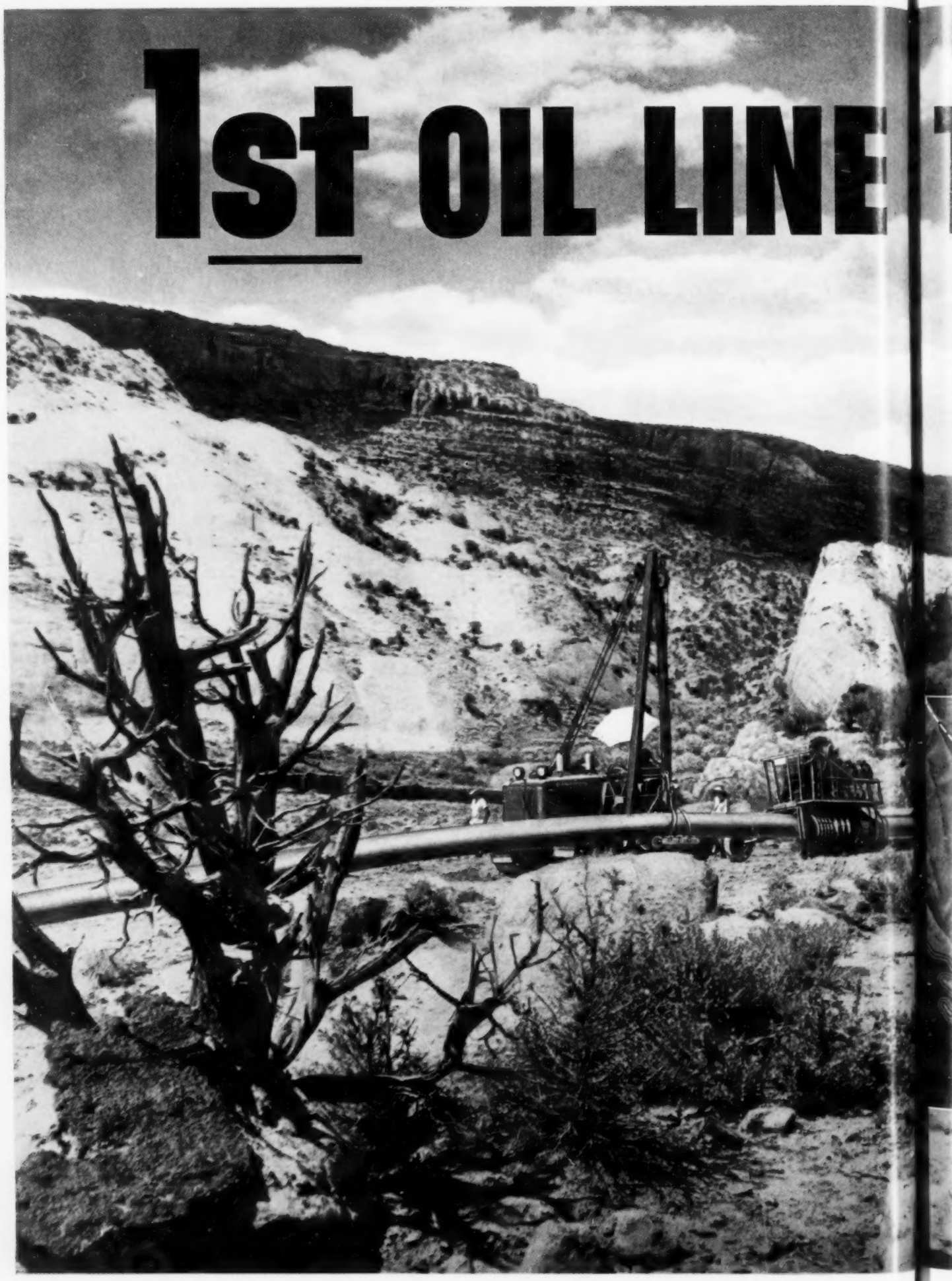
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TO CALIFORNIA

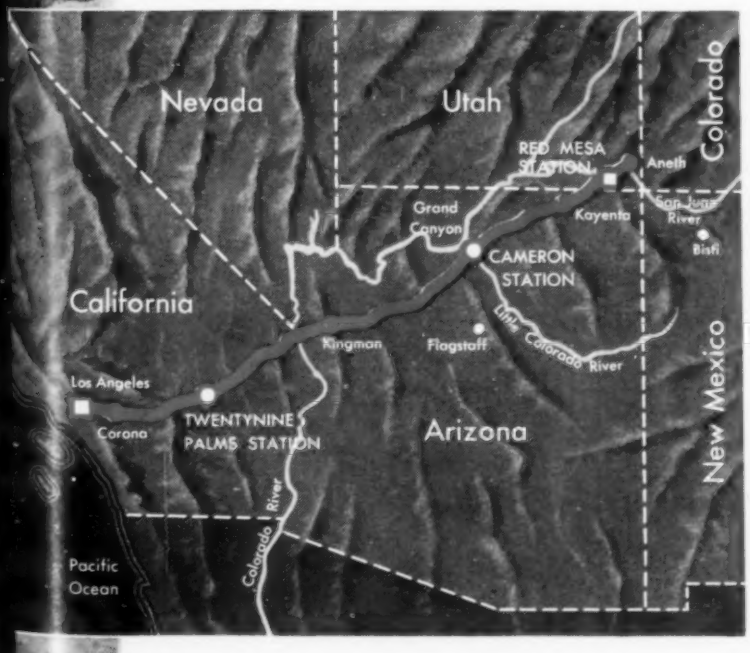
The Four Corners Pipe Line is the first line ever built to supply California refineries with oil from outside the state

Shell Pipe Line Corporation, acting as agent for the Four Corners Pipe Line Company, designed, constructed and will operate this important 16-inch line. The line itself will be owned by six companies — Continental Pipe Line Company . . . Gulf Oil Corporation . . . Richfield Oil Corporation . . . Shell Oil Company . . . Standard Oil Company of California . . . and Superior Oil Company.

The purpose of the line is to tap reserves of 250 to 500 million bbls. to meet anticipated expansion in California's economy.

A. O. Smith furnished more than 600 of the 637 miles of 16-inch main line that runs from Aneth, Utah, to Los Angeles.

For almost 30 years . . . A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe, made and installed in 1928, is still in operation. That's why so much A. O. Smith pipe is found in every important pipeline project.



From Aneth, Utah, to metropolitan Los Angeles, the line surmounts many obstacles. They include—elevations ranging from sea level to 6700 feet . . . deserts . . . three major river crossings . . . 200 miles of solid rock . . . and daily temperatures fluctuating between 40 and 120° F.

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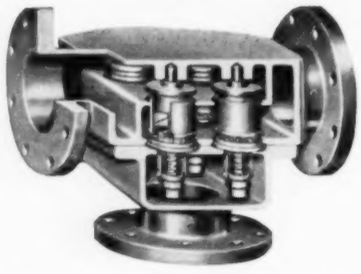
AMOT Engine Controls



AMOT is the best known name in controls for pipe line engines, and many pipe line companies have up-dated their installed equipment with the **AMOT CONTROLS** listed below.

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- **SAFETY CONTROL SWITCHES**
  Sound alarms on high water temperature or low oil pressure.
- **VENTED DIAPHRAGM GAS VALVES**
  Shut off main gas supply to gas engines.
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Available in 6", 6⅝", 8", 8⅝", 10", 10¾", 12", 12¾", 14", 16" diameters; from 14 gauge up to and including .219 wall thickness; 20, 30 or 40 foot lengths; in plain or belled ends. Quotations available for Victaulic or Dresser end processing, and coating and wrapping.

Available for immediate delivery.
Write or call for full specification and production data to: **Steel Pipe Division**

VALLEY Manufacturing Company Valley, Nebraska

New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Flow Meters

The Bristol Company has recently published a bulletin of engineering data on differential pressure type flow meters. The 22-page illustrated booklet gives basic information and theory on the selection, sizing and installation of the various types of primary devices.

Approved installation practices for gases, liquids and steam are explained and illustrated. Illustrative examples pertaining to equations for calculating throat diameters and flow rates and findings manometer ranges are given.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Caterpillar DW21

Caterpillar's 12-page booklet entitled "DW21 Reports From All Points" cites case histories of this versatile machine on the job. The two-color brochure explains the load growth curve and its relation to the lowbowl design. The illustrated publication points out varied job conditions and applications for which the DW21 is suited. Brief specifications of both tractor and trailer unit are included.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Pipe Protection

An eight-page brochure has been released by Southern Pipe Coating Company describing the firm's facilities for cleaning, coating and wrapping pipe in all sizes from ¾ inch through 12 inch.

Drawings illustrate various stages in the wrapping process, and a description is given of the Holiday detection test and other controls which assure pipe being evenly coated and protected.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Exhaust Expansion

"How to Solve the Problem of Exhaust Piping Expansion" is the title of an eight-page booklet issued by Flexonics Corporation. The illustrated brochure presents photographs and diagrams of the turbo-charging gas-engine compressors.

The problem of exhaust is explained and a solution given. Flexon expansion joints including free-flexing, controlled-flexing and Model H expansion compensator are described in detail.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Hydraulic Units

Terry Hydraulics has published a two-page technical bulletin on the company's new hydraulic pump/motor units. Performance curves and detail drawings showing over-all dimensions for flange-mounted and base-mounted types are included in the booklet.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Centrifugal Compressor

Detailed engineering data and performance characteristics, and a guide to writing specifications, are highlights of a new centrifugal compressor catalog offered by Clark Bros. Co.

Other sections in the 64-page, illustrated booklet cover the introduction to centrifugal compressor features and applications; horizontally and vertically split compressors; and a general portion dealing with compressor fundamentals, parts, drivers, engineering data and specifications.

Engineering and performance charts and equations appear in the section devoted to seals, testing and drivers for centrifugal compressors.

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

Crawler Tractor

International Harvester Company has issued a new 20-page catalog on the International TD-24 torque converter or gear drive crawler tractor manufactured by its Construction Equipment division at its Melrose Park Works.

The catalog is divided into 12 sections which describe the features of the new crawler tractor in detail. Highlighted in the presentation is a schematic drawing of the TD-24 which graphically points up all the new features.

To get a copy, circle **No. E22** on Readers' Service Card, last page this issue.

Wagon Drills

Ingersoll-Rand's eight-page flier describes the company's three wagon drills —the FM-4 wagon drill, the FM-4 rotary, and the lightweight JHM "wagonjack" mounting.

The bulletin proclaims the wagon drill as the workhorse of the three. This percussion drill is designed for rugged, sustained work on road building, general construction, foundation and quarry jobs. The illustrated flier recommends the rotary for fast drilling. Where weight is a problem the lightweight wagonjack is employed. Drill accessories are also listed in the bulletin.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

Poison Ivy Protection

Milburn Company presents a seven-page booklet designed for use in training of supervisors and workers in poison ivy and poison oak dermatitis prevention.

The illustrated booklet outlines a three-point program stressing education, personal housekeeping and avoidance of skin contact with poison ivy oils.

It explains the cause of poison ivy dermatitis, the manner in which it spreads and the course of the symptoms. Characteristic leaves and fruits of the plants are shown.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

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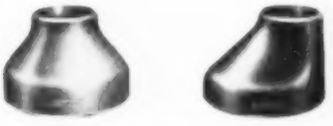

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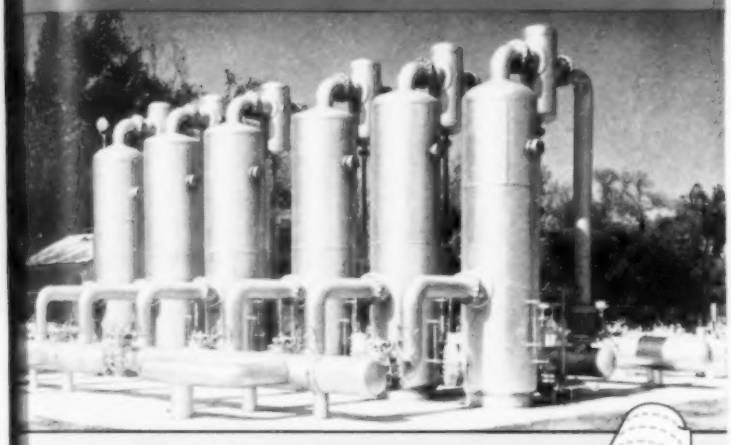
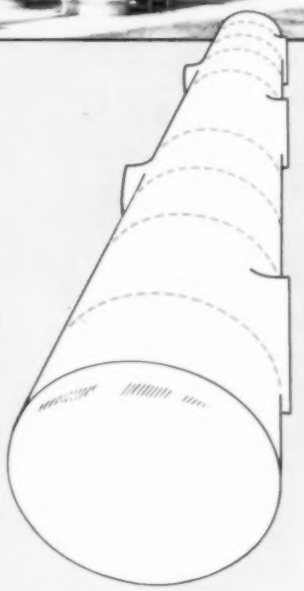
PELICAN SUPPLY CO. INC.
P. O. Drawer 1108 Shreveport (84), La.
SEE YOUR NEAREST SUPPLY HOUSE

How Oklahoma Natural compounded savings by specifying cold extrusion



Oklahoma Natural Gas Company compounded installation savings at their South River Station, Tulsa, by (1) designing for multiple outlet headers and, (2) specifying Fluor-formed headers with cold extruded outlets.

The diagram at the right shows how each of the four 20″ O.D. headers at the South River Station eliminated five 20″ × 20″ × 12″ reducing outlet tees and eight 20″ welds (indicated by broken lines on diagram)—a total saving of 20 tees and 32 welds!



By specifying Fluor-formed headers with cold-extruded nozzle outlets, these added savings were realized

1. IMPROVED STRENGTH & DURABILITY—Polished extrusion dies impart a smooth, dense surface finish to the outlet—assurance of longer service life where vibration or pulsation stresses are involved.

2. CLOSER DIMENSIONAL TOLERANCES—Flowing steel under compression while in a tough stable condition permits extremely close tolerance dimensional configurations—center-to-center and centerline location tolerances are easily held within .060″.

3. LESS MATERIAL NEEDED—Fluor-formed cold extruded multiple outlet headers need no extra length for manufacture—they are made to the exact length and wall thickness required.

4. NO DELAYS—Because nozzle outlets are cold extruded, headers are often made from stock or from the same pipe used elsewhere in a job—production is faster, inspection is simpler.

DIFFICULT JOBS A SPECIALTY

Many difficult design problems can be solved by cold extrusion techniques. Qualified Fluor Products Company engineers are ready to furnish you specialized technical information on how this process can be utilized to save you time and money.

Contact: EXTRUSION SALES, Fluor Products Company, Paola, Kansas. WRITE FOR BULLETIN CE-0.001.

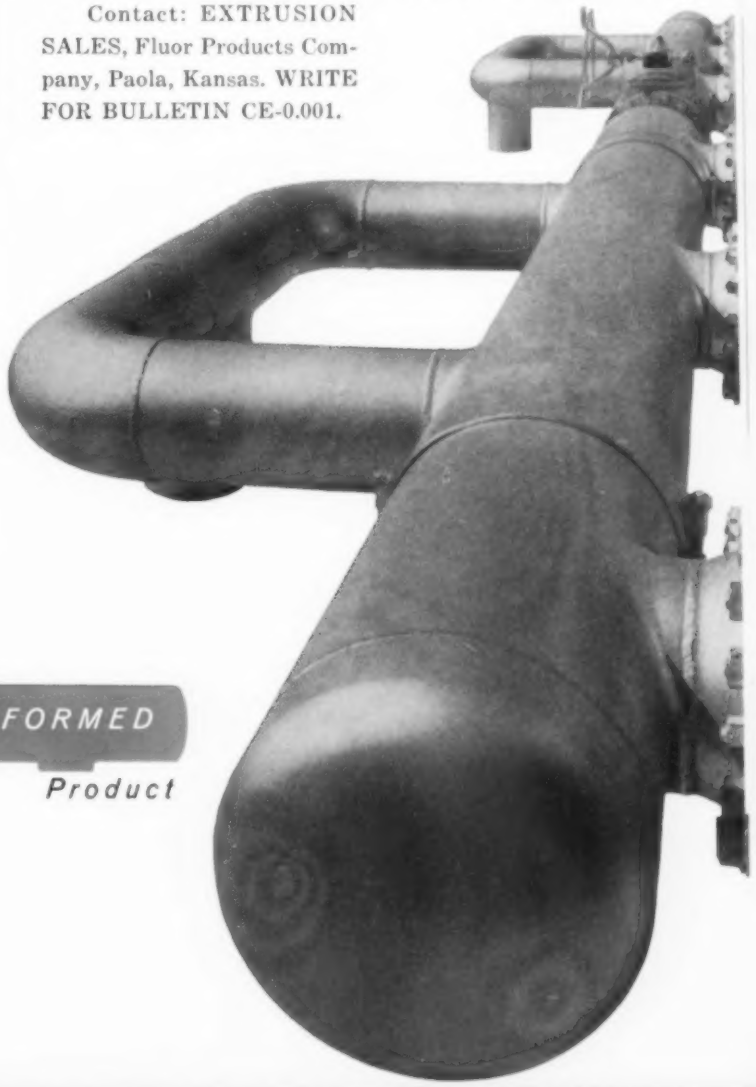


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Fig. 3466 Horizontal Triplex Plunger Pump. Maximum speed, 250 RPM. Maximum capacities and pressures: 91 barrels per hour at 1180 PSI; 179 barrels per hour at 600 PSI. Write for 1958 catalog.

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We experimented a long time—and found, when the returns were in, that we got more of what we want in Gaso Pumps. More in adaptability to various conditions. More in day-in and day-out dependable performance. More in operating and maintenance economy, and more in service life. That, in a nutshell, is why we wrote GASO into our standard pump specifications, and why we consider the policy a short cut to the results we want in pumping service.

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